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Vol. xx MARCH, 1915 No. 3

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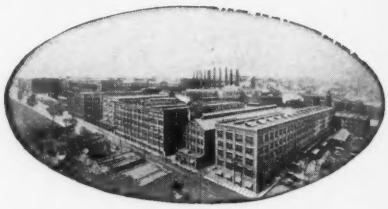

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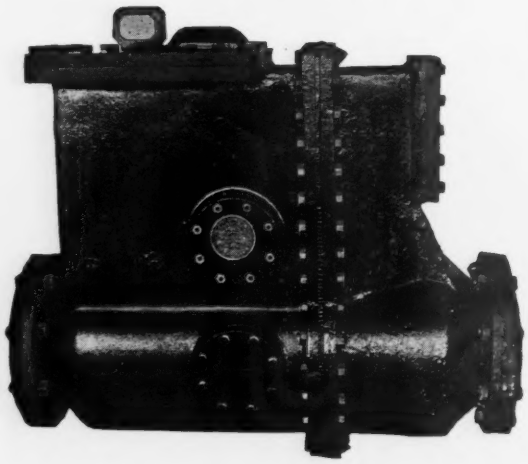

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XX MARCH, 1915 No. 3

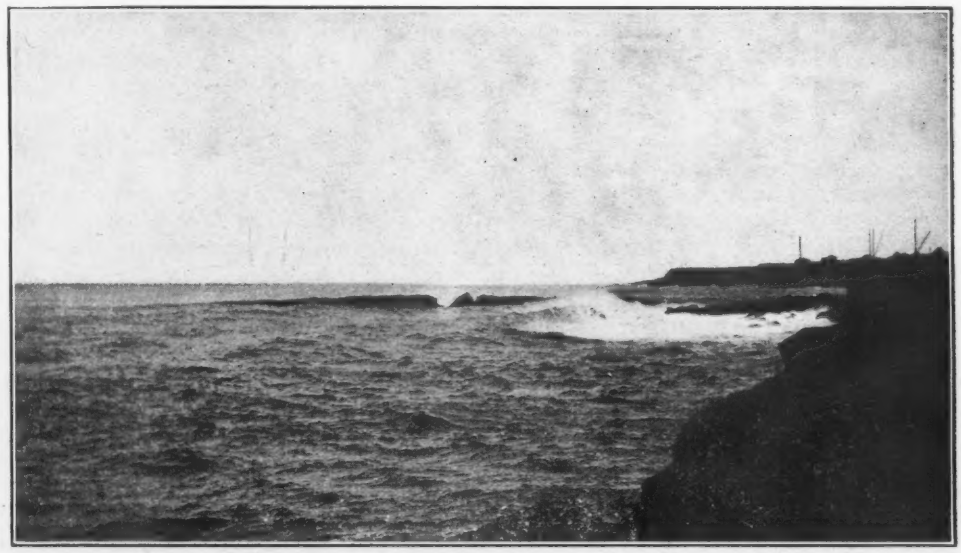


FIG. 2. TYPICAL VIEW OF COAST NEAR GLOUCESTER, MASS.

THE BRASHER AIR BREAKWATER

The destructive storms which have recently been playing fresh havoc along the coast of New Jersey, urge the necessity, and incite to the study of, the means available for protection.

In our issue of April, 1907, attention was called to the scheme of Mr. Philip Brasher for robbing the waves of their destructive force by giving to the water a certain elasticity in place of its too familiar unyielding solidity, which is accomplished by distributing compressed air up through the water from pipes laid along the bottom at a sufficient depth and parallel to the shore to be protected.

Fig. 1, on the following page tells the story in a way that renders words unnecessary. The compressor can be located wherever most convenient, or compressors used for other purposes can be connected to for emergent use. As the services of such a compressor would never be constantly required, although it should be ready to operate at short notice, an oil engine drive would seem to commend itself.

It must be conceded that this scheme has never been tried as extensively and completely as it would seem to deserve, although Mr. Brasher has followed it up until the present and has the encouragement of considerable success even with the crude arrangements which he has hitherto been able to employ.

We are enabled now to give an account of various actual experiences in the development and application of this device as communicated to us by Mr. Brasher. It will be noted that there has been in no case what might be considered a complete and altogether satisfactory

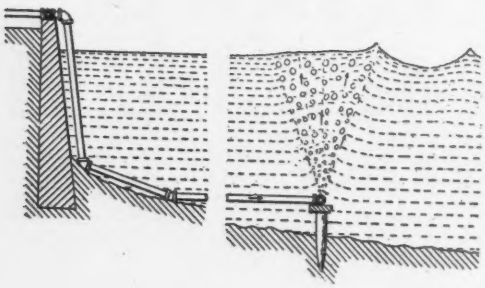


FIG. I.

installation such as the scheme would certainly seem to deserve. For instance, no compressor has been actually installed for this special service, but air has been taken for experimental purposes from compressors already in use for other lines of employment.

In the same year in which the article referred to appeared in our columns experiments were conducted at the plant of the Morse Dry Dock and Repair Co., New York Bay, for the purpose of determining suitable sizes of pipe, diameter and arrangement of holes and the actual air consumption under given conditions.

In the summer of 1908 there was a convention of the Master Car Builders' Association at the Million Dollar Pier, Atlantic City, and among the exhibits was a compressor of the Chicago Pneumatic Tool Company, and air was taken from this. There was over half a mile of pipe, 700 feet of which was 1 in. pipe, by no means all air tight, but which delivered between 50 and 100 cu. ft. of free air per minute to be discharged from the line of pipe laid out under the waves. Even this small volume of air had a decided effect on the ground swell running at the time.

The next trial was at Crotch Island, Maine, taking air from the compressors of the Benvenue Granite Company. They had two Ingersoll-Rand Compressors, one of 5400 and the other of 2700 cu. ft. free air per min. They had to go out more than a quarter of a mile from shore to get outside the reefs, etc. In a depth of 46 ft., 300 ft. of 4 in. pipe was laid, perforated with ¼ in. holes 6 in. apart, experience having determined this size and spacing to be most satisfactory. Mr. Moon, superintendent of the quarry reported that on the day of the trial waves were rolling in so high that the spray was flying over the tops of the trees along the shore. Fifteen minutes after the air was turned on he could paddle around in a canoe in the smooth water that the "air break water" furnished.

While Mr. John Arbuckle was busy with the salvage of the "Yankee," on Hen and Chickens reef in Buzzard's Bay, Mass., he telegraphed to Mr. Brasher to come and assist in

FIG. 3. AIR JUST TURNED ON.

FIG. 4. SMOOTHING EFFECT OF THE AIR.

protecting her. Several different sections of air pipe were put out in this case, only one of which is here particularly referred to. This was about 100 ft. long, with the air holes as before, about 70 feet from the vessel amidships and parallel with the hull. There were three Ingersoll-Rand compressors on the ship and the smallest of these was connected by 3

FIG. 5. AIR SHUT OFF AGAIN.

in. hose to the submerged pipe without passing the air through the receiver.

On Dec. 2, 1908, in the morning, a heavy storm having come up over night, the waves were making a clean breech over the whole superstructure of the vessel and were estimated to be from 15 to 20 ft. high. It was impossible to stay on the weather side. The air was turned on and then it was possible to take pictures from the weather side. The compressor was making 67 revs. per min., and when Mr. Brasher suggested to Mr. Wotherspoon, who was in charge, that the compressor should be speeded up a little the response was: "What's the use? Its doing the work now."

John Anderson, a carpenter and handy man on the job, says in an affidavit: that "when the air was turned on the effect was instantaneous. The waves which had been breaking over the vessel to a height of 12 to 18 feet, became long swells which were quite harmless."

At Brighton Beach, Long Island, there was a Blaisdell compressor belt driven from a Westinghouse motor. Pipes were laid here which would protect 600 feet of shore front and these were maintained two years. The depth of water was 17 ft. with sandy bottom, and it was found that after considerable periods of inaction the pipes would not choke up but would be ready as soon as the air was turned on. It was only necessary to have a little higher pressure in starting.

Near Gloucester, Mass., there was a pier at which it was sometimes difficult to land, and here a Brasher breakwater was installed. Fig. 2 is a typical view of the coast. The photos following this were snap shots from the end of the pier. Fig. 3 was taken immediately after the air was turned on. In the foreground is the 4 in. pipe going down into the water, and the white space on the surface shows the extent of the air distribution. Fig. 4 was taken after the air had been flowing for a minute or so and Fig. 5 after the air was again shut off.

It has been determined that the amount of free air required is from 3 to 10 cu. ft. per min., depending upon local conditions, the pressure of course being determined by the depth of submergence.

It would seem that the cost of an installation sufficient to completely demonstrate the applicability and value of this device should not be prohibitive. A company, the Brasher Breakwater Company, 141 Broadway, N. Y. City, has been organized in the interest of the invention and is ready to submit propositions to those who should be greatly interested.

LIGHTNING FIRES A MINE BLAST

At one of the mines on the Rand there recently occurred an accident said to be unique in the history of electric blasting and resulting in the death of four men and the serious injury of three others. The men were leaving the bottom of the shaft after having connnected up the round of holes ready for blasting, and the sinking bucket in which they were being hoisted had reached a spot about 20 feet from the bottom when the whole round of holes went off. The force of the explosion blew the bucket and its occupents on to the platform about 50 feet above them. In the ordinary way the men would have been hoisted to the surface, and, after the usual precautions to ascertain that all the men had left the shaft, the connected holes would have been fired by the switch on the surface. The accepted explanation of the terrible accident is that a fierce flash of lightning during a thunderstorm which was raging at the time struck the ropes of the skip or the guide ropes, and that these acted as a conductor connecting with the cable or the wires at the bottom of the shaft.

MOVING PICTURES OF ANTHRACITE MINING

A private view of the motion pictures prepared by the United States Bureau of Mines, showing anthracite mining from the face of the chamber to the train carrying the coal to market, was recently held at Wilkes-Barre. The merit of these pictures, which are for the education of miners, is that in them all mine rules are observed and everything is done in the proper way. All safety precautions are taken as to lights, handling explosives, examining chambers, setting props and pulling down loose coal. These films will be furnished to operators by the Bureau of Mines at cost, and will be used to show to miners' institutes and schools, and probably later to the general public as an illustration of the great expenses and difficulties incident to anthracite mining. The series was prepared under the supervision of Charles Enzian, of the Bureau of Mines, who came in for much praise for his ingenuity in overcoming the many physical difficulties attendant upon the preparation of the pictures.

GOVERNMENTAL CONTROL OF BUSINESS, DOMESTIC AND FOREIGN

BY W. L. SAUNDERS.*

There has been no governmental control of business until recent years. The very looseness of the situation, resulting in such absolute freedom of action, led men to do things in business which they would not think of doing in private life. The interests of the whole community were sacrificed for the interests of a few. Private monopolies grew up even in the common necessities of life. The abuses among railway, utility corporations and private enterprises even, in certain well defined instances, were so flagrant that it became no longer a question among fair minded men that the hand of Government was needed to restrain the tendency to commercial distraction.

It is generally admitted that a public monopoly such as a railway or utility corporation, should in the public interest be strongly held, and when so controlled it becomes unnecessary to advocate government ownership. Individual and corporate business enterprises are, however, quite distinct from public monopolies, and they should be treated accordingly. In a general way we will agree that the less Government control is put upon business the more steadily will it flourish, that legislative influence tends to impede the movement toward concentration, and represents a one-sided economic disarmament.

Government operation does not leave adequate scope for that personal initiative which is indispensable for general economic progress, nor for the needful spirit of enterprise on the part of the managers. It tends to weaken incentive of private gain, the most powerful stimulant of all economic progress. It would make impossible the free and full development of the enterprise, efficient, far-sighted personalities to whose untrammeled initiative we owe so much.

The mining industry, so characteristic of American enterprise, has been developed to its full measure of productivity through the prospect of gain. In manufacturing the progress that has been most marked in volume and value is seen in those enterprises where the control of patents has stimulated capital and individual action to their highest accomplishment We have seen this in the steel industry, which grew most where advantage was taken of new inventions to improve the processes and apparatus. We see it in the great harvester industry, the commercial development of which was distinctively on lines of invention. It is true also in sewing machines, steam, gas and oil engines, pumps, mining machinery, in textile work, shoe manufacture, etc.

Why, then, should we limit progress by Government regulation of any kind? We have our experiences in this line. In the first place Government started in with a domestic policy, of protection and patronage which practically freed the American manufacturer in most times from foreign competition, and while doing this the welfare of the people at large was at first safeguarded by internal competition which was not interfered with. It was found possible, however, to throttle this competition by combinations and consolidations of interests, so as to put the public at large at the mercy of certain trusts, which threatened to become, and in some instances did reach the position of being private monopolies.

Here we have a reason for Governmental control at home, and that control is applied under a liberal and just reading of the Sherman law, which is now interpreted broadly to prohibit only such monopolies and practices as are inimical to the public welfare. The Clayton bill now supplements this law, aiming chiefly at private monopoly and outlining generally a code of business ethics to the principles of which there can be no more objection among honest men than to the Ten Commandments. A Federal Commission has been established to aid business men to quick action under the law and to prevent unfair methods of competition in commerce.

REGULATION OF FOREIGN TRADE

It becomes, therefore, our chief concern and question as to how far existing Government regulations affect foreign trade. The question as to whether or not Government regulation *should* affect foreign trade is another matter. Legal advice from those who have studied this subject, and who are most competent to interpret the situation, is to the effect that there is nothing in the Sherman Law which prohibits price fixing, pools and trade combinations of American producers in selling goods for delivery into foreign countries. The term

*Extract from an address before the National Foreign Trade Association, St. Louis, Jan. 21-22, 1915.

"foreign commerce," which is used in the Sherman Law, is evidently intended to apply to importations and not to exportations, although both are involved in the broad term "foreign commerce." There is a large amount of business done in the United States in the sale of products of other countries.

The law, in caring for the public welfare and in preventing monopolies, includes imports as articles of domestic commerce. Apart from legal opinions, it would seem plain that the Government of the United States has no right or authority in the matter of sales made for delivery to foreign countries. It is not within its province to regulate them, as the concern and control of any country are limited to its own territory. Two men located, say, in Italy to promote the sale of American made tools have a perfect right to get together and fix prices and terms, so long as they do not violate the laws of the country in which they are doing business. Nor is it even necessary for competitors to be actually located at the foreign points of delivery, for so long as the proof exists that delivery is made outside the limits of the United States it seems plainly within the province of any one to cooperate to the fullest extent in negotiating sales.

Price fixing is not in itself immoral, nor is a monopoly immoral. They are both wrong when they are unfair or are contrary to the public welfare or when they are construed as unlawful acts, and in this case unlawful acts are such only as are unfair or contrary to the public welfare.

PLANCTON

One of the most brilliant achievements of modern biology is the demonstration of the vast variety, bulk, and importance of the living creatures, both animal and vegetable, which swarm thickly in the clearest sea-water, and are known collectively by the name of plancton. Since the ocean covers two-thirds of the surface of the globe, and since these aquatic forms of life exist throughout many fathoms of depth, instead of merely in a thin layer of earth and air as do terrestrial creatures, it is obvious that they are enormously superior in numbers and in actual "tonnage." But the very tiniest of these, the low vegetable forms which derive their nutriment directly from the water and its inorganic constituents, themselves become the food for slightly higher forms of animal life, and these in turn feed still higher forms, so that the humbler marine life is the ultimate provender of those food-fishes which supply so large and increasing a portion of the food of mankind. Millions of the planctonic creatures are either microscopic in size or so transparent as to be invisible ordinarily. However a pretty experiment demonstrates the presence of some of these tiny forms. It consists in placing a glass dish full of clear sea-water in a dark room and then allowing a beam of light to fall upon it. Just as such a beam will show the motes dancing in air it will show thousands of shining particles which are really living beings dancing in the water.

PERFECT VACUUM NOT YET

But within a one hundred and thirty millionth of it. No perfect vacuum can be even approached by any pump. After the mechanical piston pumps came the mercury pump, but that took a very long time. Then the Gaede pump, and the Geryck pump improved matters somewhat, but were not satisfying to scientists, and now we have a new device, ingenious, swift and reliable.

Suppose that we have a sealed tube containing air. If we place this in liquid hydrogen, the air in a few minutes becomes a solid in the bottom of the tube. If there were absolutely nothing but air in the tube, and if all the air were frozen we would have a perfect vacuum; but air contains what the chemist calls "traces" of several inert and hard-to-freeze gases, two of which are helium and neon. The tiny amount of these rare gases found in the air is of course left in the space, and so a perfect vacuum does not appear. But helium has been liquefied also. As liquefied helium is the coldest thing obtainable, it will not freeze any more of itself. To make the vacuum more complete, however, it was decided to put some charcoal into the tube. It had long been known that hot charcoal had the power to absorb or "occlude" gases; but little was known about its power when as cold as liquid air. A great surprise was in store for the first man to try it, however; for it was found that it absorbed a great deal more when very cold than when warm, in some cases seven or eight times as much. So the charcoal placed in the space absorbed a good part of the gases remaining, and the wonderful vacuum of 0.000000225 in. of mercury is obtained.

RETURN-PIPE COMPRESSED AIR PRACTICE

BY FRANK RICHARDS

I have before me a letter from a California correspondent who asks why it is that more has not been made of the "Cummings" system of compressed air power transmission. He says that from the results which have been actually attained by the system it could be advantageously employed in many places, especially as, besides the economy of it, there is no danger of fire or explosion, and it can be operated under water if necessary.

Notwithstanding that the return-air or two-pipe pumping system, for raising water by the direct pressure of air, is quite extensively and very successfully employed in different parts of the country, and that this system has been fully described in various publications, still I find that the essential principles of the "Cummings" system in its entirety are generally not well understood even where it happens to be known at all. Patented a full generation ago, it seems to have been exploited mostly in California, and it occurs to me that it may be quite worth while to call the attention of power users to it again.

It is a rather curious thing that the new departure which this system represents, the use of higher pressures, is quite in line with the improvements in steam engines, in gas engines, especially of the Diesel type, and in electric practice. It may be claimed, however, that the two-pipe air system "goes them one better." In the compound or the triple expansion steam engine it seems to have been the last added portion of the pressure which has secured the economy, but still the entire range of the pressure from the bottom to the top has all been retained, while the compressed air system here to be spoken of retains and uses only the higher, and presumably the more profitable part, of the pressure.

The essential feature of the system is the constant maintenance of a high pressure upon the air employed. Instead of all the time compressing fresh atmospheric air up to, say 100 pounds gage, using it in the motor at that pressure, with or without expansion, and then exhausting the air into the atmosphere again, a constant intake pressure of, say, 100 pounds is maintained at the compressor.

This air is compressed to, say, 200 pounds, is transmitted to and is used in the motor at that pressure, and then is exhausted and carried back to the compressor at a pressure of 100 pounds to be compressed and used again, and so on continuously.

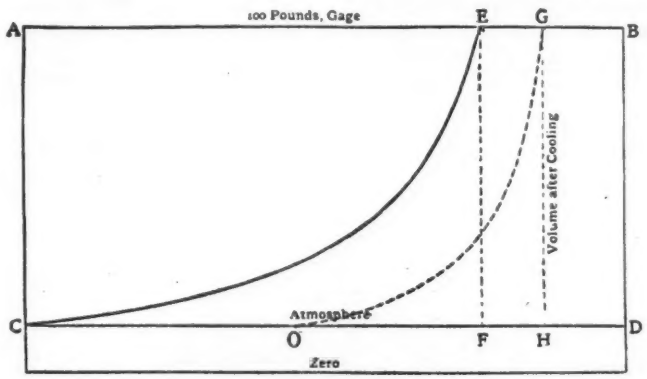


FIG. I. AIR BETWEEN O AND 100 LB. GAGE.

The accompanying diagrams, Figs. 1, 2, 3 are all drawn to the same scale for equitable comparison, and they may be studied together, although each represents an operation entirely distinct from and unrelated to the others; that is they are not successive stages of one operation. In each case the same volume of air fills the cylinder at the beginning of the compression, but the actual weights or quantities of air are very different, only Fig. 1 beginning the compression with "free air," or air at atmospheric pressure.

Fig. 1 represents the adiabatic compression of a given volume of air from atmospheric pressure, say 15 pounds to the inch, absolute, to a gage pressure of 100 pounds, or 115 pounds absolute. Fig. 2 shows the compres-

sion of an equal volume of air, but air with an initial pressure of 100 pounds gage, to a delivery pressure of 200 pounds, and in Fig. 3 an equal volume of air at 200 pounds is compressed to 300 pounds.

In each case the initial volume of air compressed is represented by the area of the rectangle ABDC. When the air has been compressed to the gage pressure specified in each case its volume is represented by the area EBDF, and this will be the volume assumed to be discharged into the pipes and receiver. As we are speaking now from the purely theoretical view-point nothing is said about the clearance losses or other allowances to be made in practice.

It is well understood that the operation of compression invariably increases the temperature of the air very much, but this temperature it is impossible to maintain, and, unless reheating is employed, the air is never used at the high temperature at which it is delivered by the compressor. As the air cools to normal temperature before it is used, its volume being reduced proportionately, the actual volume available for use is represented by the area GBDH, this being in Fig. 1 only about an eighth of the initial volume, and not much more than one-half the volume EBDF as delivered by the compressor.

The air delivered under either compression represented may be said to have equal working value, volume for volume, the available pressure being 100 pounds in either case, the air in Fig. 1 at 100 pounds working against atmosphere only, the air in Fig. 2 at 200 pounds, working against a back pressure in the return pipe of 100 pounds, and that in Fig. 3 at 300 having a back pressure of 200 pounds.

In compressing air from 100 to 200 pounds, as in Fig. 2, the temperature of the air is not raised nearly as much as in Fig. 1, and consequently the shrinkage in cooling from volume EBDF to volume GBDH is proportionately much less than in Fig. 1. The volume GBDH, here available for work is more than one-half the initial volume ABDC, or four times the volume available in Fig. 1. At the same time it is to be noted that the mean effective pressure in the compressor cylinder for the stroke, which is the measure of the actual work of compression, is decidedly less than double that of Fig. 1. Getting fully four times the available volume for less than double the power employed certainly looks like doubling the efficiency by halving the relative cost of the compression.

In Fig. 3, compressing the air from 200 to 300 pounds, the heating of the air is still less and the consequent shrinkage by cooling also is less. The available volume delivered, GBDF, is five times the corresponding volume in Fig. 1, while the mean effective pressure required for the compression and delivery of the air is less than two and one-tenth as much, which seems to be decidedly more than doubling the efficiency.

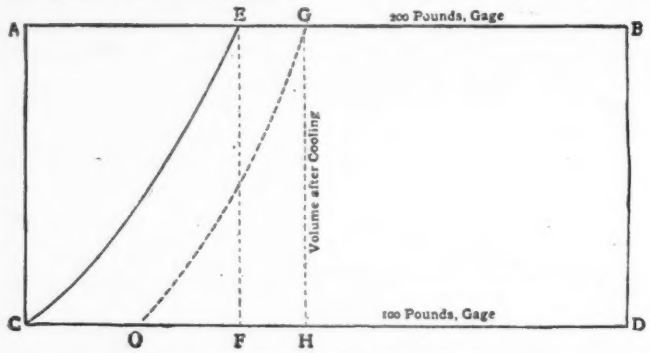


FIG. 2. AIR BETWEEN 100 AND 200 LB. GAGE.

It has been assumed in each case above that the initial air temperature is 60 degrees Fahr. With the same increase of 100 pounds in pressure the final temperatures will be 485 degrees, 163 degrees and 121 degrees the rise of temperature being, respectively, 425 degrees, 103 degrees and 61 degrees. The enormous rise of temperature in compressing from atmospheric pressure has led to the general adoption of two-stage compression, with intercooling of the air, thereby gaining something in economy, avoiding the overheating of the sur-

faces the burning of the lubricants and the danger of fires and explosions. With the heating that occurs in Figs. 2 and 3 there is no necessity for employing the two-stage compressor, and little possibility of any increased economy through its employment.

The ratio of final and initial absolute pressures is: in Fig. 1, 7.666; in Fig. 2, 1.869; in Fig. 3, 1.465. The ratio of the volume after cooling to 60 degrees, or the volume available for use, to the initial volume is: In Fig. 1, .1304; in Fig. 2, .535 and in Fig. 3, .6825. The relative costs of compression, as measured by the power used, or the mean effective pressures for the compression divided by the volume after cooling, are: in Fig. 1, 41.6÷.1304=319; in Fig. 2, 78.88÷.535=147; and in Fig. 3, 86.83÷.6825=127. Here the ratio of the cost in Fig. 1 is 319÷147=2.17, and of Fig. 1 to Fig. 3 it is 319÷127=2.51.

no additional strength required in any of the working parts of the machine, except that the air cylinder and air connections would have to be strong enough for the maximum pressure. As the same air is used over and over again in the two-pipe system, arrangements being made for making up leakage losses, there is no appreciable accumulation of moisture and no possibility of freezing up, even if sufficiently low temperatures should occur, which they do not. At the same time more or less of the lubricant is carried back and forth in the air and comes in contact with the working surfaces. As the system is a closed one, being entirely out of touch with the surrounding atmosphere and not affected by the local pressure, it will work at one altitude just as well as at another.

WHY THE SYSTEM IS NOT USED MORE.

Now as to why the system has not been

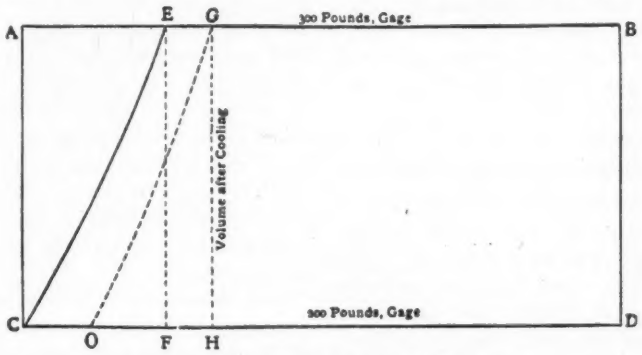


FIG. 3. AIR BETWEEN 200 AND 300 LB. GAGE.

It is understood that wherever this air is used—that is the air of Fig. 2 or Fig. 3—whether for driving a rock drill, for a steam pump or an air motor of any kind, the air instead of being discharged into the atmosphere, as it would be from Fig. 1, is piped back to the compressor with only 100 pounds of its pressure used, then, volume for volume, the air used would be of the same power value in either case if not used expansively. As the available volume delivered as shown in Fig. 2 is four times that in Fig. 1, a compressor of one-fourth the capacity, or at equal piston speeds, with a cylinder one-half the diameter, will be sufficient for the work. The maximum unbalanced pressure against the piston would be no greater in one case than in the other, only it would be continued for a longer or a shorter portion of the stroke. There would be more extensively employed; there is the fact to begin with that even yet it is not generally as well known and understood as it should be. Then evidently it would not be likely to be much used for intermittent work, such as the driving of rock drills, which are continually changing their location and where the maintenance of the return connection would cost in time and trouble enough to cancel the prospective advantage.

Apparently the best employment of the system would be for the driving of ordinary steam pumps, where constant pressure is usually required for practically the entire stroke. The air of Fig. 2, at 200 pounds pressure and 100 pounds back pressure, or the air at the higher pressures of Fig. 3 do not permit much profitable expansion in use. When used for rotative purposes in an engine or motor; the

cut-off, as the compression diagram suggests, should never occur earlier than three-quarter stroke, so that the cut-off that may be accomplished by a good slide valve engine would be all that would be available in any case. In this respect the air as in Fig. 1 would have some advantage, as it, to secure the greatest economy should be cut off before half stroke, and a certain saving would be accomplished by the expansion which would not be possible where the higher pressures were employed.

There is a necessity for the compressor supplying the air and the engine or motor using the air to approximately keep pace with each other, not necessarily stroke for stroke, but so that, with the aid of suitable receiver capacity, the delivery and the return air pressures shall be maintained as constant as possible. This implies that the two working units of the system should be adapted to each other in capacity and that an automatic pressure governor should control the compressor. More extensive installations employing several units in a single system might simplify rather than complicate the problem.—*Power.*

WINDY WINDOW ADVERTISING

A common wire waste basket was set in the window upside down with an electric fan under it placed so as to force a current of air up through a wire mesh into the enclosed space of the inverted basket. Here were put a number of dollar bills, and when the fan was started they danced for dear life in the breeze. A placard at one side said "Count the Dollar Bills and Get One Free," and the rest of the window was dressed with timely novelties which were for sale inside. The dancing dollar bills speedily drew a crowd, and although it was practically impossible to count them, all day long there were willing aspirants before the window, who incidentally got a very good idea of the location and character of the store.

AIR COMPRESSORS FOR NEW YORK CITY TUNNEL OF THE CATSKILL AQUEDUCT

On the opposite page we reproduce from Engineering News a list of the air compressors employed for the construction of the tunnels of the Catskill Aqueduct within the limits of the City of New York. This table appeared in Engineering News Jan. 28, in the third of a valuable series of articles upon the Catskill Aqueduct by Walter E. Spear, Department Engineer, 250 W. 54th St., N. Y.

While the driving of the City Tunnel did not present as many difficulties and uncertainties as the sinking of the shafts, the excavation of the tunnel, in point of cost and length of time required, was the largest item of the entire undertaking, and the plant required to do the work, though in general of standard design, contained much that was unusual from the circumstances of the work in the midst of a large city. Realizing its responsibility to the community, the Board of Water Supply made every effort to minimize the annoyance which must result from the work in the vicinity of the tunnel shafts. For example, it was provided in the contracts that electric power be used as far as practicable in place of steam, in order to avoid the noise and dirt arising from the operation of steam plants. Electric power supplied by the New York Edison Co. and its subsidaries and by the Edison Electric Illuminating Co., of Brooklyn, was accordingly used to drive all permanent equipment, including most of the compressor plants, all shaft hoists, pumps (except air-driven pumps), blowers and the motors on stone-crushing plants as well as those of the concreting plants later installed. Shafts and tunnels were lighted by electricity.

The difficulties and expense of conveying compressed air through the streets from one shaft to another led to the adoption of independent electrically driven compressor plants at each shaft, except in the northerly section, Contract 63, where conditions approximating those outside the city exist and a central steam-driven compressor plant was erected, and except in a section in Central Park where it was possible to supply three shafts of Contract 66 from a single electrically driven plant through air mains laid in the transverse roads and the sidewalk of Central Park West. The size, type and capacity of the compressor plants installed for tunnel excavation are shown in the table. This brings out the interesting conclusion that, with the losses of air that occur in the mains and in the drills and connections at the headings, and with the necessary use of high-pressure air for ventilation, not much less than 2000 cu.ft. of free air per min. should be provided, for tunnels of this size, in order to maintain sufficient pres-

Shaft	Prime Mover	Number and Type of Compressors	Nominal Capacity of Plant. Cu.Ft. of Free Air per Min. Compressed to 100 Lb. per Sq.In.	Number of Drills of Given Type Set Up Simultaneously in the Tunnels
1–5*	2 Keeler and 4 Heine water-tube boilers, 1600-hp.	2 Sullivan tandem-compound, two-stage, 2500 c.f.p.m., Type WC 2 Ingersoll-Rand cross-compound, two-stage, 2500 c.f.p.m., Class OC3	10,000	8 Sullivan 3½″ 7 Ingersoll-Rand 3½″ 20 Ingersoll-Rand 3½″ 5 Jap
6	2 General Electric, 6600-volt a.-c. motors	2 Ingersoll-Rand		
	1 200-hp.	1 1050 c.f.p.m.; Imperial Type 10 BD	1,600	†† 5 Ingersoll-Rand 3½″
	1 100-hp.	1 550 c.f.p.m.; Imperial Type 10 BD		6 Ingersoll-Rand 3½″
7	3 General Electric, 6600-volt a.-c. motors	2 Ingersoll-Rand and 1 Sullivan		
	2 200-hp.	1 1150 Ingersoll-Rand c.f.p.m.; Imperial Type 10 BD 1 900 Ingersoll-Rand c.f.p.m.; Class NE1	2,300	** 9 Ingersoll-Rand 3½″
	1 60-hp.	1 250 Sullivan c.f.p.m.; Class WJ4		
8	2 General Electric, 6600-volt a.-c. motors	2 Chicago Tool Co.		
	1 200-hp.	1 1050 c.f.p.m.; Type CBG	1,600	‡ 7 Ingersoll-Rand 3½″
	1 100-hp.	1 550 c.f.p.m.; Type MCB		
9	3 General Electric 6600-volt a.-c. motors	2 Chicago Tool Co. and 1 Sullivan		
	1 200-hp.	1 1050 Chicago Tool Co. c.f.p.m.; Type CBG	1,850	14 Ingersoll-Rand 3½″ and 3¼″
	1 100-hp.	1 550 Chicago Tool Co. c.f.p.m.; Type MCB		
	1 60-hp.	1 250 Sullivan c.f.p.m.; Type WJ4		
10	2 General Electric 6600-volt a.-c. motors		1,600	14 Ingersoll-Rand
	1 200-hp.	1 Sullivan 1050 c.f.p.m.; Type WJ		
	1 100-hp.	1 Ingersoll-Rand 550 c.f.p.m.; Imperial Type LOBD		
11	2 General Electric 6600-volt a.-c. motors	2 Sullivan	1,600	14 Ingersoll-Rand 3½″
	1 200-hp.	1 1050; Type WJ		
	1 100-hp.	1 550; Type WJ		
12	3 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand and 1 Sullivan		
	1 200-hp.	1 Ingersoll-Rand 1050; Type XB2		
	1 100-hp.	1 250 Ingersoll-Rand; Type NE1	1,550	**10 Ingersoll-Rand 3½″
	1 50-hp.	1 Sullivan 250; Type WJ4		
13–14–15*	3 Westinghouse 400-hp., 6600-volt a.-c. motors	3 Sullivan cross-compound 2100 c.f.-p.m.; Type Wn2	13–2,100 14–2,100 15–2,100	12 Sullivan 3½″ 12 Sullivan 3½″ 12 Sullivan 3½″
16	1 Crocker-Wheeler 360-hp., 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	‡6 Ingersoll-Rand 3½″
17	1 Crocker-Wheeler 360-hp. 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	12 Ingersoll-Rand 3½″
18	1 Crocker-Wheeler 360-hp., 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	12 Ingersoll-Rand 3½″
19	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	‡ 6 Ingersoll-Rand 3½″ and 3¼″
	1 164-hp.	1 900 c.f.p.m.		
20	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	12 Ingersoll-Rand 3½″ and 3¼″
	1 164-hp.	1 900 c.f.p.m.		
21	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	‡ 6 Ingersoll-Rand 3½″ and 3¼″
	1 164-hp.	1 900 c.f.p.m.		
22	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	12 Ingersoll-Rand 3½″ and 3¼″
	1 164-hp.	1 900 c.f.p.m.		
23†	1 General Electric 6600-volt a.-c. motor 164-hp.	1 Ingersoll-Rand, two-stage; Type PE 900 c.f.p.m.	900	‡ 6 Ingersoll-Rand 3½″ and 3¼″
24†	1 General Electric 6600-volt a.-c. motor 164-hp.	1 Ingersoll-Rand, two-stage; Type PE 900 c.f.p.m.	900	‡ 6 Ingersoll-Rand 3½″ and 3¼″

tral plant for these shafts. Later each compressor at plant for Shafts 13, 14 and 15 was piped separately. † One heading only ly one heading running full. †† Bench drilled from heading columns. ‡ Drilling in one heading only. at this shaft.

LIST OF AIR COMPRESSORS ON N. Y. CITY TUNNEL OF CATSKILL AQUEDUCT.

sure to drill up two headings simultaneously with piston drills of the largest size. For the independent plants at each shaft, the plan adopted on Contract 67, of two compressors, one smaller than the other, appeared to be preferable to a single unit, because the smaller of the two machines could be run more economically, when only a small amount of air was required, and one of the two could always be depended upon to be in operation. The amount of energy a single shaft required for all purposes during tunnel driving amounted to 40 to 50 kw.-hr. (54 to 67 h. p.-hr.) per cu. yd., exclusive of trimming, and the peak loads ranged from 300 to 400 kw. (400 to 535 h. p.)

THE BUREAU OF MINES WORKS FOR SAFETY

The life savers of the United States Bureau of Mines have, according to the statement of Dr. Joseph A. Holmes, the director, rescued more than one hundred entombed miners from certain death. More than this, he asserts in his annual report that volunteer rescuers in the employ of mining companies and trained in rescue work by the bureau have saved many other men. As a result of the example set by the bureau, rescue and first-aid organizations have been established at many mines and more than 1,200 sets of rescue apparatus have been purchased by mine owners. These stations are expected to save the lives of many men in the future.

The bureau in the furtherance of its work now maintains six mine rescue stations, eight mine rescue cars, and one rescue motor truck, located in the mining districts of the country. The cars visit the various mining camps and train the men in rescue work and also in first aid to the injured. This movement has reached the point that whenever there is a mine disaster it is now possible to obtain a sufficient number of trained volunteers to take care of the rescue in an orderly and systematic manner and without the great loss of life so frequently found among the rescuers in the past.

The work of the states in carrying out their part of this program in mine safety is being carried forward in a reasonably satisfactory manner. The states are already spending in their inspection and police-supervision work more than the Federal Government is spending in all of its investigations in behalf of mine safety. Thus, for example, a single state, Pennsylvania, maintains a well-organized and efficient inspection force at a cost of $213,000 each year.

"Many of the mine owners have begun a system of operations in which safety is considered of first importance. More than 170 mining companies have individually, or through the association of two or more companies, established seventy-six mine-rescue stations at which there are 1,200 sets of rescue apparatus besides the auxiliary equipment for first-aid and fire-fighting work. There are also twelve mine-rescue cars now operating by individual companies about their own properties.

COMPRESSED AIR FOR SAFETY IN TEXTILE MILLS

BY CHARLES C. PHELPS.

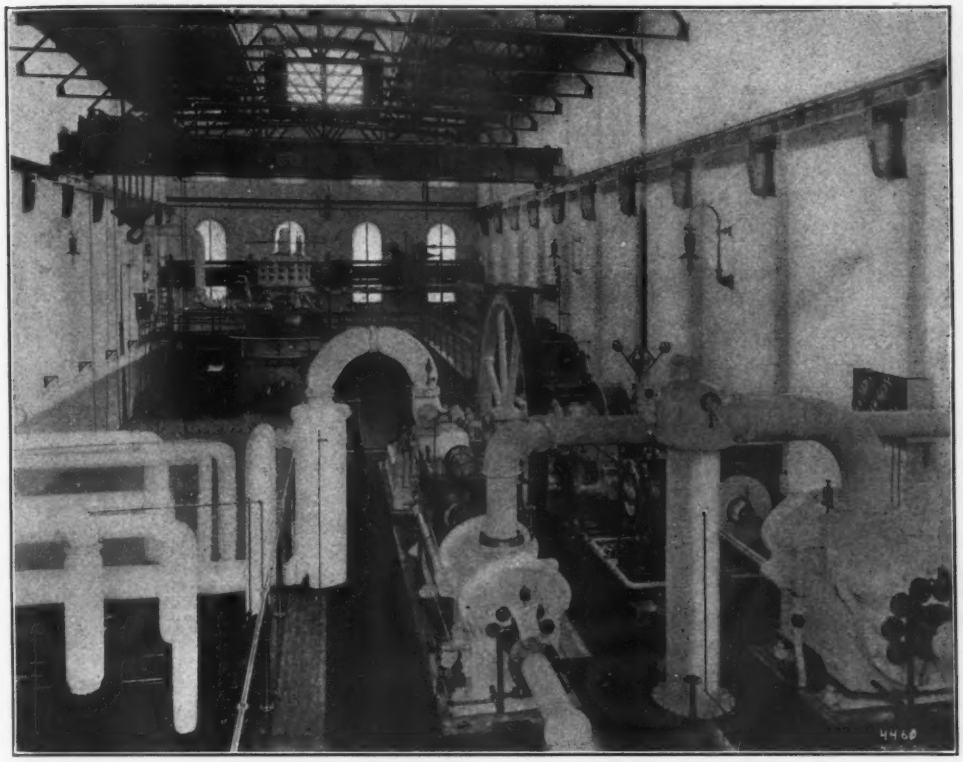
The greatest fire hazard in the textile mill lurks in the staple in course of manufacture. The next greatest hazard probably is found in the lint and dust which spread about every room where the manufacturing is conducted. This material finds its way into the most inaccessible places, and if permitted to accumulate, it furnishes an ideal medium for converting the smallest spark into a disastrous conflagration. Textile mill superintendents are aware of this very imminent danger and naturally attach great importance to the subject of mill cleanliness, largely on this account.

COMPRESSED AIR CLEANING.

The air jet has proven to be the most effective means of dislodging lint from the inaccessible places and thus minimizing, if not actually eliminating, one of the most serious sources of danger. Aside from the thoroughness of the compressed air method of cleaning, it as been found by experience that an actual economy can be effected, as the cleaning is accomplished more rapidly, most of the machines do not have to be stopped while being cleaned, and there is therefore an actual increase in production.

The air jet is used for cleaning practically every machine used in textile manufacturing. Pulleys, shafting, overhead beams, pipes and wires and ceilings may also be cleaned without the use of ladders, by air supplied through a nozzle screwed into the end of a long hollow tube. Unless overhead cleaning is done outside of regular working hours, the nearby machines must be stopped and dusted afterwards to prevent the lint from getting into the work. Less stoppage, however, is necessary than when the overhead cleaning is done with brooms and brushes, as the work is accomplished in much less time and more thoroughly. Compressed air is regarded as almost a necessity for cleaning electric motors. The lint gets into the air spaces of motors, raising the temperature and affecting the efficiency; hence frequent blowing out becomes necessary.

Compressed air cleaning was naturally first tried out in mills using air for other purposes, as for atomizing water for humidification, as in such places the economy to be gained from



AIR COMPRESSOR AT AMOSKEAG MILLS.

using a single piping system for a double service is apparent. Many mills are today equipped with compressed air for this double service; in addition there are several equipped with compressed air service for the sole purpose of cleaning.

PNEUMATIC HOISTS ECONOMICAL.

Where heavy lifting has to be repeated frequently or intermittently there is no device that can compare with the pneumatic hoist for the purpose. There are two general types, the cylinder hoist and the pneumatic motor hoist. These may be mounted in a fixed position or used as portable hoists by suspending them from trolleys running on an overhead I-beam rail. Both types are clean, convenient, foolproof, simple and absolutely without fire risk. The fire risk of a portable electric hoist, is a serious matter. There is always a possibility of the swinging feed wires fouling about some obstacle and causing a short circuit.

The economy of pneumatic hoisting is remarkable. The cost of operation will figure considerably under 1-1,000 of a cent per foot of lift per hundred pounds in the majority of cases.

Pneumatic cylinder hoists are used in textile mills for such purposes as transferring material from vat to vat in dyeing and bleaching, for raising and dumping trucks of bobbins upon the feeder aprons of conditioning machines and similar apparatus, for operating heavy doors and gates, for lifting heavy bales from tanks and vats, and for a number of similar operations where the lift is repeated over a fixed height.

Where the height of lift is variable, as in lifting bales and placing them on different levels in a warehouse, the air motor type is preferable. It is also more compact, requires very little headroom and has a much greater travel than the cylinder type. For this reason, it is also suitable for handling building material, for lifting machinery from floor to floor, for handling ashes and other waste material, etc.

The pneumatic drill is one of the handiest

tools that can be used in a textile mill. Any operation that can be performed with a hand or electric drill or auger can be performed better and quicker with a corresponding pneumatic tool. The hand drill is slow and is very limited in power. The electric drill is fast enough but it limited to a single speed and the wires leading to it are a source of danger. The pneumatic drill can be run at any speed desired up to its rated limit and there is no risk of fire.

Besides using such tools in connection with hanging shafting, roughing out belt holes, cutting out holes in walls and ceilings for wires and pipes, for setting machinery, for drilling in metal and general repair work, the motors of these tools are often rigged up for special purposes, as for operating circular saws for cutting out worn mill flooring or roofing, for operating heavy valves, for cutting out old boiler flues and tubes and expanding new ones into the headers, for cleaning tubes in water tube boilers and for operating small machines of various kinds. Similar advantages are possessed by other pneumatic tools, as chipping and riveting hammers, which are great time and labor savers for general repair work.

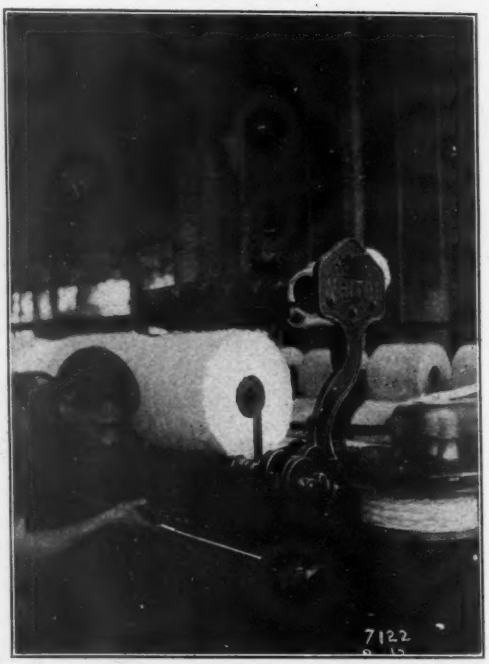
PNEUMATIC MOTORS USEFUL.

The motors of pneumatic drills have been mentioned as being extremely handy for operations requiring small amounts of power. For similar power purposes on a larger scale, stationary pneumatic motors are commonly employed. These motors are particularly recommended for intermittent service in locations where the fire risk is high due to the proximity of inflammable material or to the absence of attendance. Familiar uses for these motors are for operating cranes, saws, grindstones, emery wheels, filter presses and other small machines and short lines of shafting. Mounted on portable frames, they are useful for shifting machinery and for hoisting building material, machines, etc.

The thorough practicability of compressed air as a source of power is further demonstrated by the fact that many industrial establishments are using compressed air locomotives exclusively for hauling material in bulk.

COMPRESSED AIR AS AN AID IN FIRE PROTECTION.

An attempt has been made to cite a few textile mill uses for pneumatic power and to show how the fire hazard is actually reduced by such applications. Presses, pumps, elevators and a variety of other apparatus are also



CLEANING MACHINERY IN A COTTON MILL.

operated by compressed air at times. The same statements covering the absence of fire risk apply to all such applications.

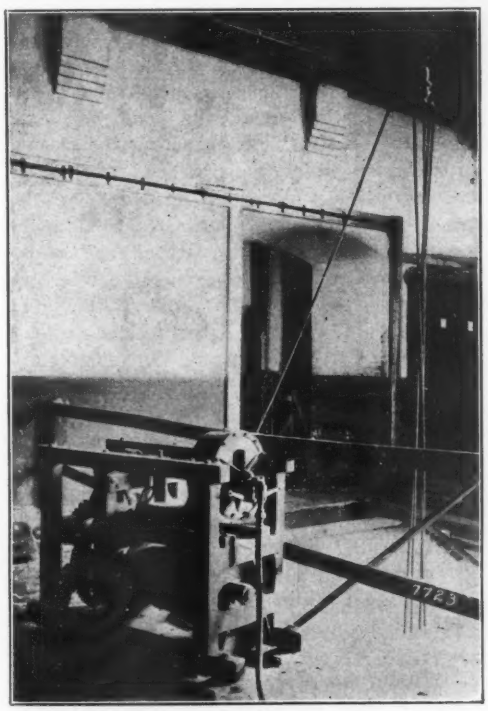
The air lift is a favorite method of obtaining an abundant and reliable supply of pure water from deep wells. Due to the absence of working parts in the well, there is but little likelihood of such a system failing at a critical time, as in the event of a fire. Other systems of compressed air pumping, as the pneumatic displacement pump and the return air system, are also noted for their reliability, and hence are frequently adopted for the main or reserve water supply. The best fire extinguisher system made will be of no use should the water supply fail hence the reliability of the water supply should be the first thought of the factory superintendent.

In unheated buildings, such as storehouses, it is necessary to employ some means to prevent the automatic fire extinguisher pipes from becoming frozen and inoperative during the winter months. The common practice is to keep the pipes throughout the building filled with air under pressure. This necessitates the use of a special valve, known as a dry-pipe valve. In a properly installed dry-pipe system, with periodical inspection, the protection is

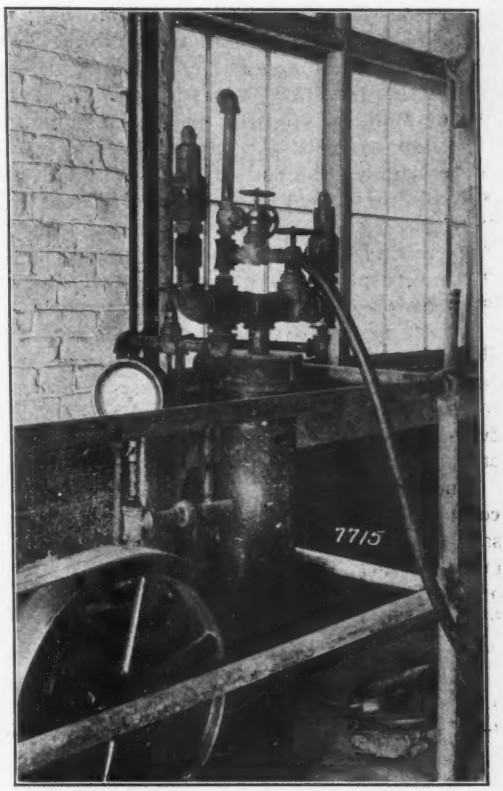
practically the same as with a regular sprinkler equipment.

Pneumatic whistles are used for fire alarms in many localities. By employing air-tight receivers with the whistles, the pressure is always ready to blow the whistle. A steam whistle for this purpose has the disadvantage that the boiler operating it is liable to be shut down at some time when most needed. Air whistles are sometimes worked in connection with electrically driven compressors, so connected that when the whistle starts to blow the compressor automatically starts up and maintains the required pressure in the receiver.

As the losses in transmitting compressed air over considerable distances are negligible, and as one or two large compressors are more efficient and require less attention than several small compressors scattered about a plant, it stands to reason that a large central air plant is preferable. Likewise when air is used for several purposes about a mill, the cost per operation is less than when it is used for a single purpose. It is for this reason, combined with the considerations of safety, that so many mills adopt compressed air for a number of purposes, after trying it out on a single application.



A PORTABLE AIR HOIST.



COMPRESSOR AND VALVES FOR ACID TRANSFER.

Sometimes compressed air is wanted for brief periods in different places around a mill. In such circumstances a portable electrically driven compressors furnishes a satisfactory solution. Such a compressor can be connected with the nearest electrical socket and operated either within or without the building in which the air is to be used.

There are many instances on record of mine fires and small explosions in which at least some of the men would have escaped in safety if they had taken the intake airway instead of the return. Even if the return is not strong with afterdamp and smoke when you enter it, you may be suffocated by a sudden increase of smoke or harmful gases before you can get out of it.

ELECTRICITY IN COAL MINES

In his annual report submitted to the Secretary of the Interior, Dr. Joseph A. Holmes reviews the investigations made by the Bureau of Mines to safeguard the miners from electrical accidents. Director Holmes makes the declaration that not only have many men been killed or injured from what are believed to be unnecessary electrical accidents, but indirectly electrical apparatus has been responsible for mine explosions and mine fires that have extensively destroyed both life and property.

He further says that, through the activity of the bureau in calling attention to dangers heretofore unappreciated in the use of electrical machinery, manufacturers have devised safer types of apparatus and states have enacted stricter laws governing electrical installations.

Much attention has been paid to the proper construction and use of electric and other safety lamps. Tests have been made to ascertain the comparative merits of different types of safety lamps, including their usefulness in furnishing light to miners, their relative safety, and their value in indicating the presence of explosive gas. The well-defined principles that govern the mechanical construction of a modern safety lamp have been largely exploited in this country by European manufacturers and covered by patents in this country. During the present year some of these patents have expired and in consequence American lamp manufacturers and lamp agencies have been inspired to develop new models. Already an improved safety lamp of American manufacture has appeared, and samples of others have been received by the bureau for examination and criticism. The bureau has studied all types of safety lamps on the market and as a result has prepared a schedule of official tests to be used in establishing a list of permissible safety lamps for use in gaseous mines.

At the beginning of the year the bureau's requirements for testing explosion proof motors had been prepared and published. The work was necessary because no successful explosion-proof motors had been developed in the United States. During the year only one motor was submitted for test, but this machine passed the tests successfully. It is believed that the bureau's approval will stimulate other manufacturers to renewed activity in producing such motors.

In the investigation of the ignition of coal dust by electric flashes, valuable results have been obtained. Coal-dust ignitions have been obtained under practical underground conditions with currents of surprisingly low voltage. The danger of dust explosions being started by such currents has been shown, but the work needs to be continued to determine the extent of the danger and how it may be nullified.

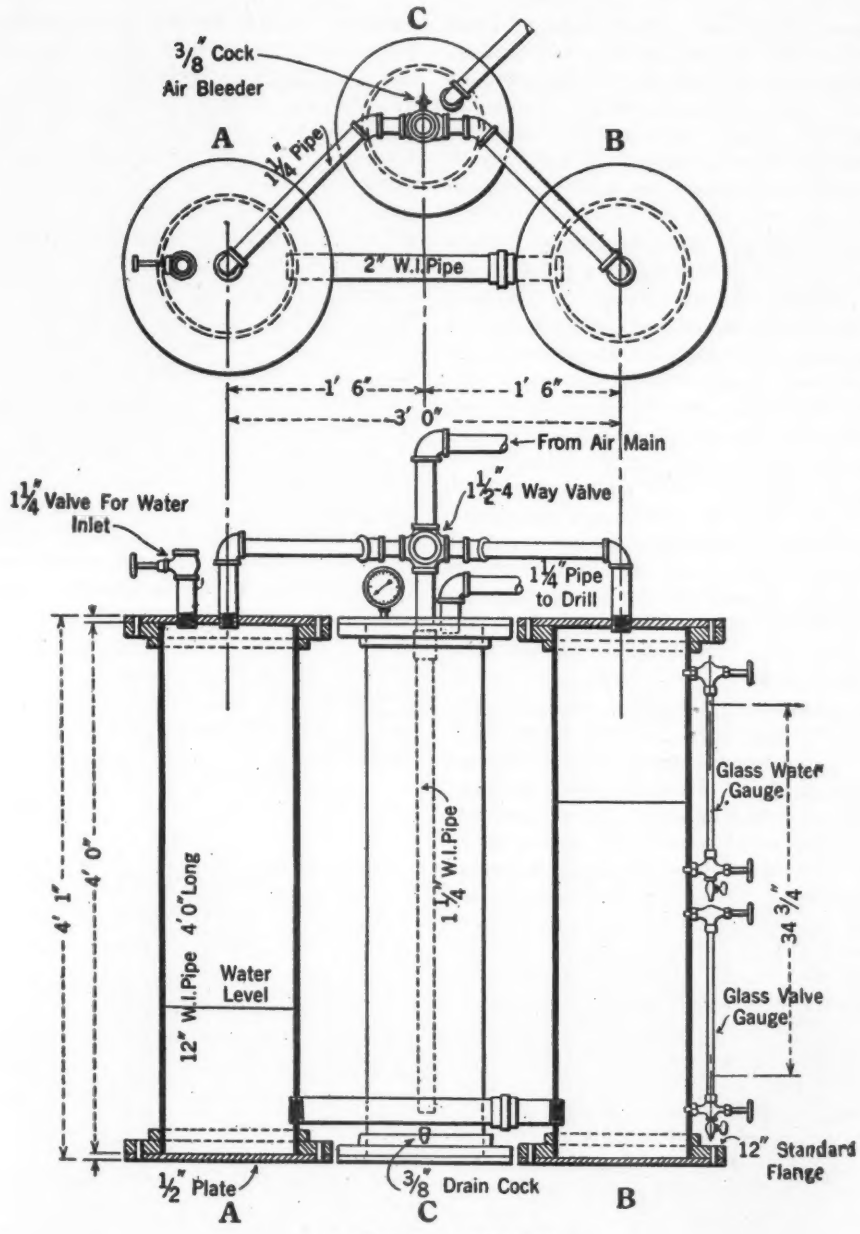
TESTING HAMMER DRILLS FOR MINE SERVICE—METERING THE AIR*

BENJAMIN F. TILLSON.

The hammer drill rightly receives the credit for having made the one man drill possible, and so many economies seem possible through the proper application of different types of hammer drills to various mining, quarrying and excavating operations, that an indication of the economies effected by the New Jersey Zinc Company at its Franklin mines may be of pertinent interest.

When this company commenced its trial of hammer drills in 1907, those tools had not been developed to one-fourth the capacity and refinement which they have at present. At that time it was frequently asserted that such a small tool, drilling holes of less diameter than the reciprocating rock drill, could not drill enough holes in a shift to permit the placing of sufficient explosive to break a tonnage of ore comparable with that produced by the "rock drills," that the placing of small holes inclined upward, at angles steeper than 40 degress above the horizontal, could not be expected to produce results equal to the large flat, wet or dry, holes in the breasted back of an overhand stope, and would only shatter the ground so as to make the back unsafe. In spite of these adverse opinions, however, the hammer drills first showed their superiority over both heavy and light reciprocating drills in raising and stoping, and then in drifting and quarry work. As a result, all of the reciprocating drills at the Franklin mines were scrapped three years ago, all of the mining work being accomplished with increased efficiency.

*Introductory portion of a paper before the American Institute of Mining Engineers, Feb., 1915.



AIR METERING APPARATUS.

With the advent of the hammer drills in this property, it was considered advisable to make comparative tests of all the tools accessible and it has since been the policy to investigate the merits of any advance of the drilling art, in order to get the maximum amount of work from the tools. The necessity of devising some means of standardizing drills tests, and of measuring the consumption of compressed air as well as the drilling speed was early realized.

The common test was to fill a measured air receiver with compressed air at a certain pressure, run the drill until the pressure had

dropped to too low a figure, then compute from the time, drop in pressure and capacity of the receiver, the cubic feet of free air used. This was not considered a fair indication of the drilling capacity of a machine, since the performance of some drills did not vary directly with the absolute pressures of the compressed air.

It was, therefore, found expedient to build a water-displacement air meter with which the drill test could be carried on for any length of time without serious variations in the desired air pressure. This apparatus, as shown in the cut, consists of two tanks, half-filled with water, and made of 12-in. pipe with blank flanges, gauge glasses being mounted on one, a four-way cock connecting the compressed-air supply pipe with both tanks and the air line going to the drill. This device gives more accurate results than the common types of water or gas meters; and since any errors are due to the human element of reading the gauge glasses and reversing the four-way cock, they tend to be compensating throughout a number of tests.

The procedure is as follows: Air is drawn by the drill from the receiver *C*, which tends to trap any moisture carried over by the air from tanks *A* and *B* and assures a constant pressure while the four-way cock is reversed. In the arrangement as shown, the receiver draws its supply of air from the tank *B* and the water rises in this tank by virtue of the pressure of the air admitted from the air main through the four-way cock to the top of tank *A*, where the water is being forced downward and through the 2-in. connecting pipe to tank *B*. When the water has risen to a certain point near the top of the gauge glass in tank *B*, the four-way cock is reversed and the inlet air is supplied to the top of tank *B*; the drilling air is then taken from the top of *A* the reversal of the cock again being made when the water in tank *B* has fallen to a point near the bottom of the gauge glass.

A pet cock is placed on the top of tank *C* so as to permit the bleeding of air to bring the water columns to the desired point for starting a run, and another pet cock is attached to the bottom of the same tank in order to permit the drainage of water. For convenience in measuring and computing, a run is made on the supply of compressed air indicated by a certain number of reciprocations of the water columns between fixed points on the gauge glasses; the pressures are measured on the air gauge mounted on tank *C*, the length of time is taken by a stop watch, and the consumption of free air per minute is computed. Unless a pressure regulator is installed between the four-way cock and the receiver *C*, or else a globe valve at this point is operated manually to throttle the air so as to maintain a constant pressure, it is evident that the air pressure at the drill will vary in accordance with the water column supported by the inlet air pressure, but since the gauge-glass marks are in this instance set 34¾ in. apart, the maximum variation in pressures is about 1¼ lb. per square inch; it is difficult to find a pressure regulator which will control a pressure of 90 or 100 lb. per square inch to a closer degree of accuracy, and the sensitiveness of the drills to air pressure and the accuracy of time and distance measurements rarely exceeds this error.

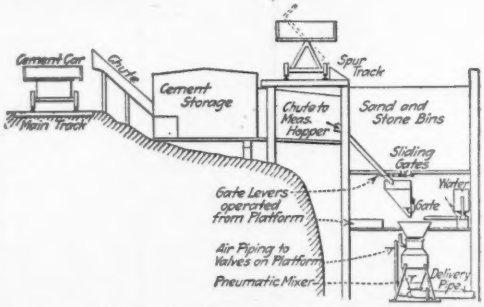


FIG. 1. CONCRETE MIXING PLANT.

A LARGE COMPRESSED-AIR-CONCRETE CONSTRUCTION

In the construction of a new reservoir for the Montreal Water & Power Co. on Mount Royal, Montreal, Que., the concrete for the walls and for a dam at one end was mixed and placed by compressed air. This process is on the MacMichael system, and the mixer was furnished by the Pneumatic Concrete Mixing and Placing Co. for the contractors, Laurin & Leitch. F. H. Pitcher, General Manager and Chief Engineer of the Water Company, is in charge of the work.

The mixer had a capacity of ½ cu. yd. of mixed concrete per batch. The air was supplied from a steam-driven compressor located about 1,100 ft. from the mixer, in the central power plant, the air being led to the mixer

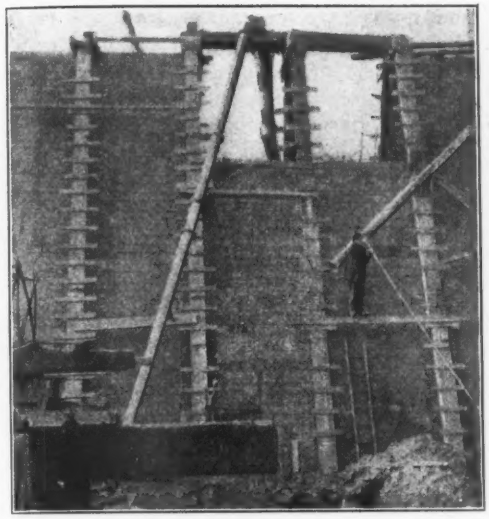


FIG. 2. PIPE TO TOP OF FORMS.

through a 6-in. line, with a storage tank at each end of the line.

Fig. 1 is an approximate section through the concrete plant, and shows the arrangement of tracks, cement shed, stone- and sand-storage bins, measuring hopper, water tank and pneumatic mixer. Cement was unloaded from electric cars on the main track, and the sacks were thrown from the cars into inclined covered chutes which led to the cement shed. For the unloading of sand and stone a standard-gage spur from the main line was laid on a short trestle running past the bins. Stone was dumped directly into the 200-yd. bin over the mixer from 6-yd. side-dump cars. Sand was delivered in box-cars and shoveled into a large auxiliary bin at one side of the mixer, the 90-yd. sand bin over the mixer being fed from the auxiliary bin with a bucket conveyor.

In the bottom of the storage bins were sliding gates, operated by hand levers, through which the materials were delivered into the two compartments of the measuring hopper immediately over the mixer. The cement was fed from the cement-storage shed by a gravity chute opening into the stone compartment of the hopper. On opening a gate, the contents of the measuring hopper would slide into the mixer and at the same time a measured amount of water was directed against the stream of falling materials, all falling into the mixer chamber together.

The concreting pipe ran from the mixer to the wall forms, where the pipe had a vertical rise of about 37 ft., and continued along the top of the forms around curves to the end. This pipe is 8⅝ in. outside diameter, made of steel, lap-welded, and weighs about 17 lb. per

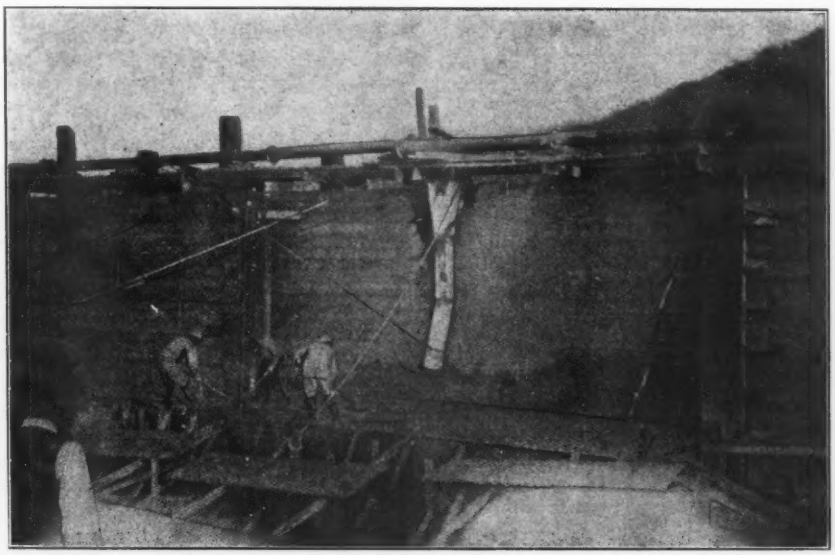


FIG. 3. CONCRETE DEPOSIT CHUTE.

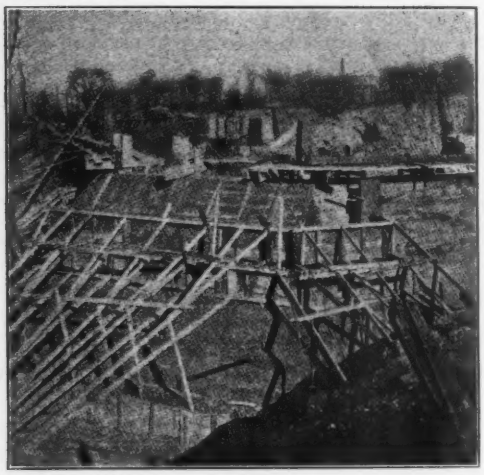


FIG. 4. CORNER OF WALL.

ft. Slip flanges of special design make connection and disconnection an easy matter. At any joint an elbow could be bolted on and the concrete directed into the forms from that point, allowing the stream to shoot directly to the form or employing a "boot-leg" to spread the concrete in wide forms. The pipe was well tied to the forms at bends, on account of the force of impact of the batches which, traveling at great speed, tend to throw the pipe out of line.

On the dam a derrick, which handled the "plums" used in the wall, shifted the riser pipe from section to section as they were poured, the main pipe being laid on the ground at the foot of the form. Each section was poured in three lifts, the conveyor pipe rising 15, 30 or 37 ft. for the lifts.

The greatest distance the charges were conveyed was 600 ft. This includes a 37-ft. rise from the ground to the top of the forms at about 100 ft. from the mixer, and curves between the mixer and discharge elbow aggregating 400 degrees. The operation at this distance was slower than at a shorter distance on account of the greater volume of air required to discharge, a pause for the air pressure to rise being necessary between shots.

Progress on the wall was necessarily slow, due to the fact that it was poured in alternate sections, averaging about 30 cu. yd. each, which necessitated many form and pipe changes. The average rate on the wall was 100 yd. per shift, which usually filled all available forms. On the dam progress was much faster because of larger sections, the average rate being 250 yd. per day. High rates of pouring were attained, but could not be maintained long owing to lack of material, necessity for changing pipe, or the fact that too much liquid concrete could not be poured into a form at once. On most days the rate of pouring varied from 30 to 50 yd. per hr.

During the time this work was carried on there were days when the temperature was down to zero, but no difficulty was experienced on this account. The water and sand were heated and the operator's platform inclosed. As only a few seconds were required for transit, the concrete went into the forms hot, and in the large masses with heavy forms there was no chance of freezing.—*Engineering News.*

TESTS OF A GAS-ENGINE-DRIVEN AIR COMPRESSOR

We reproduce here, mostly as a matter of record, an abstract, from the Journal of the American Society of Mechanical Engineers, of a report of the Boiler Inspection Society of the Mining District of Dortmund, Germany. It relates to a compressor installation at the Consolidation Mine in Germany.

While gas engines have been used widely to drive electric generators, their use for air compressor operation in Germany appears to have been very small and only in installations of an experimental nature. The present installation, therefore, represents a very bold advance involving a compressor handling per hour 15,000 cbm. (say 530,000 cu. ft.) from atmospheric pressure to a pressure of 6 atmospheres gage. The gas engine is a four stroke cycle twin tandem engine working on coke-oven gas with a heating value of from 4,000 to 4,500 WE, (448 to 504 B.t.u. per cu. ft.). The high pressure and low pressure cylinders of the air compressor are directly connected to each of the sides of the gas engine, each side of the engine being so designed that it can compress as a single stage compressor from 4800 to 7000 cbm. (169,500 to 247,200 cu. ft.) per hour to a pressure of 5 atmospheres, according to whether the high or low pressure cylinders are operated. The arrangement is such that even when the engine is being cleaned, or undergoing repairs, the compressor is still partly running.

Duration of test, hr.	6
Barometer pressure, mm. water	753.75
Temperature of air sucked in, deg. cent./fahr.	13.25/55.9
Temperature behind the low pressure cylinder, deg. cent./fahr.	102.8/217.1
Temperature behind intermediate cooler, deg. cent./fahr.	31.4/88.6
Temperature behind high pressure cylinder, deg. cent./fahr.	112.8/235.1
Compressed air pressure, atmospheres gage	6.6
Volumetric efficiency of compressor, per cent	87.7
R.p.m.	90.6
Air output of compressor, cbm/cu.ft.	15,277/539,493
Power consumption of compressor, i.h.p.	1479
Indicated output of gas engine	1774
Mechanical efficiency of the plant, per cent.	83.4
Low pressure side:	
R.p.m.	73.5
Volumetric efficiency, per cent	49.9
Air output per hour, cbm/cu. ft.	7051.6/249,004
Compressed air pressure, atmospheres gage	5.1
Average temperature of compressed air, deg. cent./fahr.	138/280
High pressure side:	
R.p.m.	87.3
Volumetric efficiency, per cent	72.9
Air output per hour, cbm/cu.ft.	4767.2/168,345
Compressed air pressure, atmospheres gage	4.9
Average temperature of compressed air, deg. cent./fahr.	138/280

RECORD OF COMPRESSOR TESTS.

When the engine is operated at its full capacity of 15,000 cbm. per hour it has a speed of 90 r.p.m. The compressor has Horbiger-Rögler plate valves conveniently located in a valve chamber in such a way that they can be easily exchanged. In order to attain as low an air temperature as possible and, further, in order to comply with the police requirement that the temperature in a single stage compressor should not exceed 140 deg. cent. (284 deg. fahr.), the walls of the compressor as well as the compressor piston are water-cooled. The intermediate cooler which permits the cooling down of the partly compressed air to the temperature of suction is placed in the floor in an accessible position. A tube filter of the Blass type is used for cleaning the air in suction.

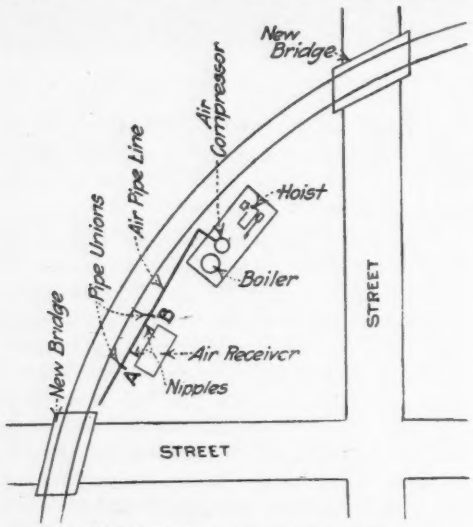
The engine was subjected to an acceptance test in the period from September 29th to October 4th, 1914, and a further control test on October 13th. The work of the cylinders of the gas engine and compressor were determined by indicating the air pressure and temperature by properly calibrated manometers and thermometers, while the heat content of the gas was determined by analysis and by means of a Junker calorimeter.

In order to eliminate the influence of outside temperature and the action of sun rays on the gasometer, all the tests were carried out after the sun went down. Nevertheless it has been found in testing the air tightness of the gasometer that the pressure lever continued to sink after sundown and this led to the control test on October 13th. The data of the test are shown in Table 1. This test has shown that the plant as it stands did not satisfy entirely the very exacting requirements of the contract but that it was fairly efficient. During the entire test, the engine ran quietly without causing any trouble, and no disturbances of any kind in the operation of the plant were observed.

ROCK DRILLS ARE NOT STEAM ENGINES

The United States Court of Customs Appeals has decided that rock drills and bar hoists are not "steam engines" within the meaning of the tariff law. The collector had classified the articles under the act of 1909 as manufactures of metal, and took duty at the rate of 45 per cent. under paragraph 199. The importers went to the Board of General Appraisers with the claim that the machines fall under paragraph 197, at 30 per cent., as "all steam engines." Presiding Judge Montgomery, in his decision for the court said the real question in the case is whether the articles in

the condition as imported come within the meaning of the term "steam engines." He discussed the testimony and concluded as follows: "The attachment which is added to this machine and becomes a part of it as imported was designed for the purpose of adapting it to making it usable as, and only as, a compressed air machine, and only usable by applying compressed air, whereas to constitute it a steam engine a change in the appliance must be made, not only by adding an attachment, but by removing the attachment from the machine as it is imported and substituting another, something which we have no reason to expect will occur or was ever contemplated by the importer or any one dealing with such articles."



SHOWING LOCATION OF RECEIVER.

AIR RECEIVER MAKES TROUBLE IN A RIVETING OUTFIT

A curious case of trouble in a riveting outfit, dut to carelessness in arranging and locating the air plant in such a way as to avoid trouble from dust, is described by a correspendent. The work was the erection of several street-crossing railway bridges, where the air plant was laid out to supply several bridges some blocks apart. The riveting gangs were frequently delayed by dust, etc., clogging the ports and valves of the hammers. This was finally traced to two things, the absence of suitable screens at the compressor inlet—the operator thought such a refinement unnecessary in the field—and the unsuitable arrangement of the air receiver. The plant was placed about halfway between two bridges which were some 300 ft. apart. It consisted of boiler, hoist and winch and air compressor, and from here a 1½-in. pipe extended to both bridges. The air receiver was located near one of the bridges. It was cut into a branch or bypass of the line instead of into the main airline itself. Furthermore, on account of the lay of the ground, the main pipe was lower than the receiver, so that there could be no draining down into the receiver, but rather the reverse. As will be seen from the nature of the arrangement, the receiver had no action in the way of removing dust or moisture from the air, and since the railway traffic stirred up a considerable amount of dust alongside the roadbed, the unscreened compressor inlet allowed quantities of dust to get into the system and pass by the receiver to the hammers.

The above, including the title, we reproduce from *Engineering News,* Jan. 28. It is well to thus call attention to the carelessness too frequently shown as to the apparently minor details of compressed air installations. We cannot but think, however, that in this case too much stress is laid upon the mode of connecing the air receiver. As the normal flow of the air did not pass through the receiver, of course none of the dust could have been deposited there; but if the receiver nad been so connected that all the air used would have passed through it, only a very minute portion, if any, of the dust in suspension would have been left there.

A cheap and simple air strainer at the intake would have caught the dust before the air entered the compressor, and that would have been the last of it. Such a strainer any one with normal gumption should be able to devise and construct. For instance, make a frame or skeleton of a cubical box, say two feet on the side if for a small compressor, and cover the sides of the frame with or three thicknesses of cheesecloth. Then let the intake pipe get all its air from the interior of this box and the dust will be found on the outside of the box instead of in the pneumatic tools. It would be a profitable refinement to make arrangements for keeping the cheesecloth or burlap wet, and of course it would be necessary to occasionally wash off the accumulated dirt.

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EVERYTHING PNEUMATIC

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AT LEAST DESERVING A FAIR TRIAL

The first article in our present issue should be at least of interest to our readers. It sets forth a scheme which can only be said to be questionable, and being questionable there are two opposite possibilities suggested. It may be practically worthless or it may embody a solution, partial or complete, of a perplexing problem. We are presenting it merely as a matter of general interest in the compressed air field, and without being understood as in any way endorsing the scheme. We are willing, however, to say that trials have been carried far enough for Mr. Brasher to make it appear, as we might say, that there may be something in it. The photos presented are far from convincing. If they had been taken from the beach instead of from an elevation the differences in the condition of the water surface would have been more apparent, and an actual sight of the phenomena exhibited would have been more satisfactory. The confidence exhibited by Mr. Brasher and those associated with him, who are familiar with the developments up to date, is a factor of value in the present situation.

To fairly try this device for robbing the waves of their destructive effect there is perhaps no better opportunity than along the coast of New Jersey, where the losses have been so severe and where they are so certain to continue. The trial mentioned at the Atlantic City pier was absurdly inadequate for the purpose intended, suggesting Mrs. Partington's broom, and, besides that, there are places along the coast which have been more unfortunate and which are more in need of protection. A score or more years ago, perhaps the most attractive popular day steamboat excursion out of New York was that to Long Branch. On account of the uncertainties involved it could only be conducted in a half-hearted way at the best, and now it is among the regretted recollections, because the landing pier could not be maintained. If that pier could have been made secure and permanent, and if the encroachments of the sea along the coast could have been stopped, say by the Brasher system, the cost of compressors and piping would have been absurdly small as compared with the property and business values secured. It would be quite possible to demonstrate at that point, or along the

coast line there within a few miles, whether the system would be effective and dependable, but not by a makeshift plant. It can only be decisively determined by an actual trial installation complete in every detail and sufficient if successful to be maintained as a permanency.

AMERICAN INSTITUTE OF MINING ENGINEERS

At the annual meeting of the American Institute of Mining Engineers, listed as the one hundred and tenth meeting of the Institute, at the Engineering Building, New York, Feb. 16th, the following officers were elected:

President, William L. Saunders; Vice Presidents, Sidney J. Jennings and Philip N. Moore; Directors, S. A. Taylor, Robert W. Hunt, Hennen Jennings, George C. Stone and W. H. Aldridge. Secretary and Treasurer are elected by the directors.

The most notable paper presented at the meeting was by Dr. Walter O. Snelling, a research chemist of Pittsburgh, on a process for making gasoline from "synthetic crude oil." B. B. Thayer, President of the Anaconda Copper Company, the retiring President of the Institute, announced a gift of $5,000 from Dr. James Douglas to be used for the extension of the library. Announcement was also made of a gift of $1,000 from Sir Robert Hatfield, to be awarded next year for the best essay by a member of the Institute upon some mining engineering topic.

GUESSING A RIDDLE

A correspondent asks us: What is the approximate production of compressed air in the United States, free air measurement?

As to the answer to this our correspondent knows as much as we do, and compressor builders probably know precisely the same. Nevertheless, here goes:

Say that there are in the U. S. 10,000 compressors averaging 1000 cu. ft. per min. each; the output for a year, 12 hours per day, 300 days would be:

$10{,}000 \times 1000 \times 60 \times 12 \times 300 = 2{,}160{,}000{,}000{,}000$ cu. ft.

At 2 cents per 1000 cu. ft., which is cheap, this would amount to $43,200,000.00, which total we seriously think is much too low.

This is for bona-fide compressors for compressed air service. Then there are the blast furnaces and foundries whose volume used would be several times as much as this, and the air brake and the beer pumps; and after all there would be the hot air, which is past all computation.

UNDECORATED GENERALS

Gen. Von Kluck and his army made a really impressive march from the Belgian frontier to the gates of Paris, but how much of that victorious march was due to Von Kluck and how much due to some presumably spectacled and narrow-chested individual living in a perpetual atmosphere of tracing paper and calculations in the great gun works at Essen? And when the French, with their terrible "seventy-fives," achieve a victory (i. e., advance a hundred yards or so along part of their line), has not the designer of the "seventy-fives" rather more to do with it than the officer in command? It might not be too much to say that the real winners of modern battles are not soldiers nor sailors, but certain quiet civilians of a studious frame of mind.—*Scientific American.*

SUIT TO RECOVER A FOG

A reduction or abolition of fog as ground for damages in a stream diversion case was recently brought forward in Pennsylvania in a suit against the Johnstown Water Co. The complainant alleged that the building of a dam by the company so reduced the flow in a stream passing by the complainant's land, that prevalence of fog over the land adjacent to the stream was reduced, and in consequence the crops suffered from frosts from which the fog had previously shielded them.

The combination of methods, means and men employed in driving the Rogers Pass Tunnel is keeping up its record breaking, record making pace. The advance of the west pioneer heading, as given in our February issue, was 817 ft. in November and 852 ft. in December, and now comes the figure for January, 932 ft., a bigger jump than before.

A single power transmission line, carrying 140,000 volts, now extends from Bishop Creek to San Bernardino and thence to El Centro, Cal., a total distance of 404 miles.

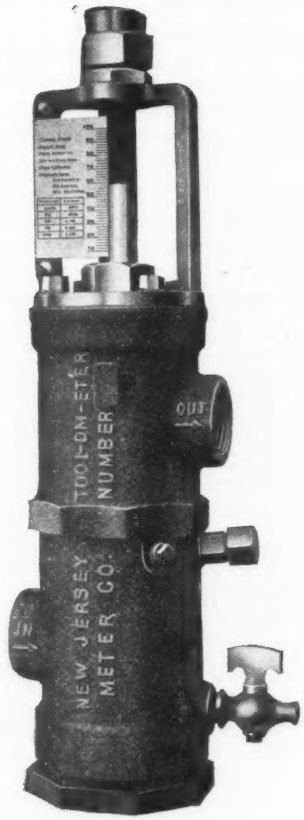


FIG. 1.

THE TOOL-OM-ETER

This is a new device whose use is well suggested by the name which has been invented for it. It is for measuring the air which goes through a pneumatic tool or any air driven device when in operation. Of the "long felt want" of such a device, simple, cheap, handy and reliable, it is not necessary to speak.

Fig. 1 shows the Tool-om-eter externally and Fig. 2, is a section by referring to which the principle of operation may be easily understood. It is always to be used in a vertical position and is connected to the air supply of the tool whose air consumption is to be measured, the air entering by the large opening near the bottom on the left hand side and escaping through the opening at the right. As the air enters it passes up into the interior of the central cylinder and passes out through the small holes with which this cylinder is perforated and so reaches the discharge opening. The holes are located practically over the

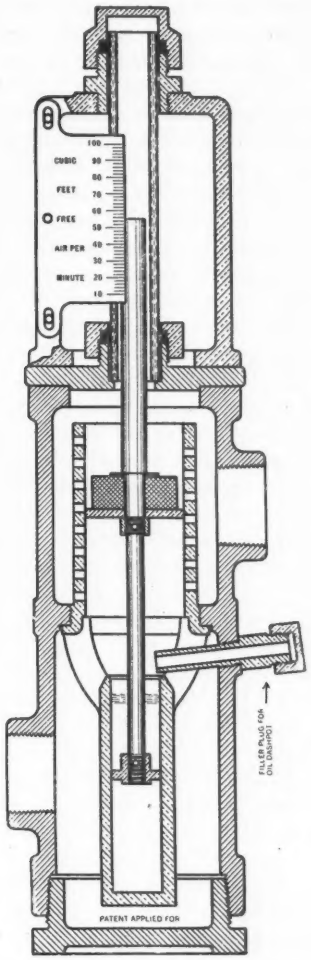


FIG. 2.

entire cylinder surface although unfortunately only those on the section line are indicated in the cut. When the piston is at the bottom of the cylinder no air will be passing through the instrument and the reading at the scale above will be zero. As air begins to pass the piston rises, uncovering successively the holes around the cylinder, the number of holes uncovered varying with the volume of air passing through. This is in accordance with the familiar law deduced by Poncelet: *The volume of a definite compressed fluid or gas flowing under small constant head through multiple orifices of the same shape and size, is directly proportional to the number of orifices exposed to the flow.*

The rod which carries the main piston is

continued upward and travels in a glass tube through which it may be seen, the end of it locating the correct reading on the scale at the side. The lower end of the rod carries a piston travelling loosely in a dashpot of oil which steadies the movement. The reading of the scale on the instrument here shown is from 10 to 100 cubic feet of free air per minute, which makes it suitable for most small pneumatic tools, such as chipping and riveting hammers, hammer and air feed drills, wood boring and metal drilling machines, the bosses being threaded for 1 in. pipe. Another size for 2 in. pipe, with scale reading from 50 to 300 cubic feet, is suitable for standard rock drills, coal punchers, sand blast, etc.

If the toolometer is connected into the discharge line of a small compressor its action is of course just the same, and it shows the rate of air compression as accurately as its consumption. As will be seen there is apparently nothing to wear out and certainly nothing to break and from the material used, there is also nothing to corrode. Built by the New Jersey Meter Company, Plainfield, N. J.

A MINUTE STUDY OF ROCK DRILLING SEQUENCES*

BY BENJAMIN F. TILLSON.

Perhaps the consideration of the physical phenomena relating to the process of drilling may prove of interest and value. When rock is excavated by a drill bit three applications of force seem to be involved: by abrasion, by crushing, and by severing or chipping. Although all of these must take place to a certain degree, the greatest amount of useful work is performed when the percentage of force applied to chip reaches a maximum. But in rock it appears that chips can be produced in radically different ways: first, by the severing of molecules, and second, by the reflex forces produced in an elastic medium. To illustrate this, consider the chipping of a comparatively inelastic substance such as lead. With a hammer and a chisel, whose axis is inclined considerably from the normal to the surface of a lead block, it is possible to sever the lead and roll up chips, but if the chisel is normal to the surface of a thick block only an indentation can be made and there probably will be a raised area about the indentation to accommodate a certain percentage of the displaced metal. On the other hand, with a highly elastic material, such as glass, the forces impressed by a normally positioned chisel will cause a compression of the molecules, whose elasticity will cause their expansion toward a free, unresisted surface. Since the greatest forces are developed at the surface, since the penetration of the chisel carries some forces to a depth below the surface; and since the chisel surface itself applies some forces at an angle to its axis and impedes the re-expansion of molecules to the space it occupies, therefore, the reflex forces produce more or less cone-shaped chips or flakes and leave a corresponding crater in the block of glass. Now, if the chisel is placed near the edge of a block of glass, the blow upon it will induce stresses to another free face and a correspondingly larger chip will be produced because of the tendency of the forces to seek relief in the shortest direction as well as because of the severing effect. The method of cutting of a drill bit is commonly shown as taking place in this last way with the progressive chipping of a series of benches or steps, but it is doubtful whether such a procedure exists, except in rare instances, for the speed and latitude of rotation between consecutive blows of the drill piston or hammer cannot be controlled with sufficient precision nor adjusted to the various rocks; and an inspection of the cuttings from a drill hole shows them to be flakes, or a crushed and abraded powder.

In the formation of these flaky chips there may be a limiting force of blow for each velocity of impression in order to gain the most useful work (*i. e.*, in the production of flakes), for it appears that beyond certain limits the blows increase the percentage of crushed material and the drilling speed does not vary with the force applied, so that some heavy-hitting drills accomplish more in medium-soft ground when a portion of their blows are absorbed by a tappet at the shank end of the steel or by a cushion of water intervening between the bit and the rock. If the force of the blows was lessened by a reduction in air pressure the speed of the piston would be slowed up, and the drilling would suffer from the fewer number of blows per minute.

The transmission of the kinetic energy of the piston to the rock is also influenced by

*Extract from paper before the American Institute of Mining Engineers, Feb., 1915.

many factors. The blow may be delivered against the rock by the free drill steel which is driven forward through the intervening air or water by the impact of the piston and the velocity of the steel will depend upon the relative masses of the drill steel and piston, the velocity of the piston, and the coefficient of elasticity of the steel, in accordance with the well-known laws of mechanics which deal with elastic or partly elastic bodies and their impact. The drill steel in this way assumes the functions of a "jumper" drill which is driven against and rebounds from the rock at a high frequency, and its action is well seen in most all screw-feed hammer drills with the ringing or jingling of the steel in a drill hole. Another mode of force transmission is by compressional waves, traveling through the drill steel from the shank to the bit. This latter condition brings a cutting effect only when one end of the steel is tight against the rock, but then proves very efficient. Although the air-feed hammer drills usually chatter the steel against the rock, like a projectile shot from the chuck bushing by impacts of the piston, yet it seems possible to approximate the other working condition by designing the air feed so that the pressure is lowered as the piston is traveling on its back stroke (possibly by taking the supply air, for the back stroke, from the air feed) and so that the air-feed pressure builds up and forces the drill against the rock just before it is struck by the piston. The reversed-air feeds may sometimes approximate these conditions and then assist the machine to a higher drilling speed. If hammer drills were made so that the drill steels were always held firmly against the rock, when the piston strikes them, it seems unquestionable that the greatest efficiency of the blows of the piston would result, providing they were properly timed, for no energy would be lost by reason of the inertia of the drill steel, but only that due to heating, resulting from the imperfect elasticity of the metal. The question of the proper timing of the piston blows opens another phase of the matter, namely, the reaction of the rock upon the drill steel; and this effect is the more pronounced with harder rock. It tends to speed up the piston and is so noticeable in running a machine against a metal block as to invalidate, as too high, all air-consumption tests so conducted. The effect of these reactive vibrations upon the drill steel may prove very marked and serious. Where the reactive vibrations interfere with oncoming compressional waves, considerable energy is dissipated, and at times one may be so fortunate as to detect points of increased temperature (probable nodes) upon a drill steel which is cutting ground; and it is no uncommon thing to see a drill steel, in service, break at two points (into three pieces) simultaneously, probably from fatigue because of these vibratory stresses. On the other hand, if these vibrations synchronize at the bit it is quite possible that the chipping forces are greatly augmented, and such an explanation may readily answer those puzzling drill tests in which a dull or broken bit exceeds a finely formed bit in drilling speed. For a long time at Franklin a tally was kept of the different individual drill steels which entered into the testing, with the hope of determining that some particular piece of steel produced the greatest cutting speed, but no conclusion could be drawn from the records, except that the changes in length due to resharpening probably masked any possibility of determining the suitable lengths for maximum efficiency. And it seems quite plausible that such a result should be expected if the possible wave lengths of the compressional vibrations in the drill steels are considered. Probably these reactive vibrations occur to a great extent, as well, in the process of drilling, where the steel dances in the chuck and against the rock, for steel breakage appears equally as high, if not higher, with such a type of machine as with the pneumatic feed, and tests comparing these two types for such effects might prove very interesting as well as instructive.

But still other factors influence the force delivered at the rock. If the anvil block or tappet is not in contact with the drill when the piston strikes, a considerable energy loss occurs through the transference of momentum to several pieces. If the steel is bound in the chuck bushing, a great amount of the energy is absorbed by the friction. If the steel is not straight, it loses energy because of the flexure. If the chuck is badly worn, the axis of the steel does not coincide with that of the drill and there is a loss due to the oblique, eccentric impact. If the steel is tight in the drill hole, or if the friction against the side of the hole is great because of its depth, the velocity of the steel, as a projected body, is lessened and the drilling speed is reduced.

The length of the drill steel is an item generally credited as an important influence, and common opinion supports the idea that the cutting speed falls as the length of the steel increases, although some people, on the contrary, feel sure that the long steels drill the fastest. The tests conducted at Franklin do not lend an unqualified support to either view, for the peculiarities of different types of machines play so important a part. For example if the air feed is very strong in a stoping drill the additional counteracting weight of a long and heavy steel may so improve the working conditions as to indicate a superiority for the long steel, and if the air feed is weak the reverse may be true; if the drill steel cuts by virtue of a dancing or "jumper" action, the mass added with length may so reduce its velocity against the rock as to bring it below the amount required for efficient chipping; if the piston normally delivers too heavy a blow for the rock, the drilling speed may be improved by the added inertia of the long steel; and if the steel is always against the rock when a blow is delivered, it is doubtful whether the length of the steel plays an important part unless the permitted decrease in the gauge of the drill bits aids the cutting speeds. It is, of course, to be understood that the above considerations of drill-steel lengths refer to the performances with bit gauges of the same diameter.

The use of an anvil block is considered by some drill designers to necessitate a loss of from 20 to 30 per cent. of the power of a drill but actual tests do not always indicate such a condition when the identical steel is tested in the same drill with and without a tappet. The results probably depend upon how frequently the tappet is struck when away from the shank of the steel, and also upon the suitability of the machine to the rock, for if its blows are too heavy the intervention of a loose tappet might reduce their force, with a benefit in drilling speed. The use of water at the bottom of the hole ordinarily consumes about 10 per cent. of the cutting speed if there is no tendency for the drill bits to lose their temper, and compressed air for cleaning the holes encourages a greater drilling speed, providing the cushion of water in the bottom of the hole does not have a benign influence in reducing too powerful a blow upon the rock.

The manner in which a drill is rotated has a bearing upon the amount of work accomplished, and with hand-rotated tools, a vigorous rotation with a rapid and wide arc of swing produces the best results; with power-rotated drills it is possible to reach such a speed as to abrade and dull the drill bits, and consequently lessen the drilling speed. It seemed that, with a positive and constant rotation, the axial planes of the cutting edges of the drill bits should be at the same angle with the cut surface as the resultant velocity vector, as estimated for the rotative and striking velocities; and such a bit was tried at Franklin without showing a change in cutting speed, probably because with either bit the chips came out in flakes, as previously described.

NOTES

Manufacturers of valves, cylinders, recording gages, filling and weighing stands, and of materials and appliances entering into the manufacture, transportation and sale of compressed gases, are requested to send catalogues, price lists and full descriptive details to the Secretary of the Compressed Gas Manufacturers' Association, Inc., 25 Madison Avenue, New York City.

An illustration of the danger of gas being ignited by incandescent lamps used for lighting the drilling rigs of gas wells is given in a recent field report of J. J. Rutledge, mining engineer of the Bureau of Mines. The driller on duty at the time of the fire declared that a pebble blown from the well struck and broke an incandescent lamp bulb, so that the gas from the well was ignited by coming in contact with the broken filament. The resulting fire totally destroyed the rig and caused considerable additional damage.

The most northern railroad in the world is to be strictly an electric one. It is located near Porjus Falls, in Lapland, one of the largest in that northern peninsula. The building of the power plant was a government project, costing about $5,000,000. The economic justification of this outlay is that the new Lapland railway is expected to bring ore from the great Arctic iron mines.

This may sound like a joke, but it is not. A certain zinc smelter reports that he is now getting everything out of his ore but the

"squeal." Asked to explain what he meant, he said that he is now putting up in barrels the residuum from his retorts and selling it as a specific against hog colera. There is active demand for the substance for that purpose. It is said that the zinc residuum spread over the hog yard stamps out the germs of hog cholera and the hogs experience no further trouble. Nobody offers any explanation. This is simply reported as a thing that is so.—*Eng. and Min. Journal.*

Experiments have been conducted in Austria on the maturing or aging of wines by refrigeration and aeration. New wines in bottles and casks were first subjected to a temperature of 28.4 to 26.6 deg. Fahr. (at which temperatures they did not freeze) for a period of from 24 to 48 hours, after which they were aerated by passing air through them for 24 hours or racking them off and allowing them to fall in a shower through air. While red wines showed no effects from the treatment, in white wines the color was darker and the taste and fragrance had decidedly more the character of old and ripe wines than in the untreated samples. There was found to be a marked decrease in the content of nitrogenous matter; i. e., the same effect as that ordinarily produced in wine by keeping it a long time in cellerage and racking it repeatedly.

Not long ago an inquisitive field mouse shut down more than half the mines and mills of the Porcupine gold camp of Ontario and interrupted the production of gold for half a day. The mouse got into a switch on the transformer house at the Jupiter mine and made a short circuit. A generator was burned out at the Sandy Falls power plant and the mishcief was done. The Hollinger and all other companies using the Sandy Falls power were without power for half a day. No mouse can do the trick more than once.

When the United States revenue cutter Seminole was being overhauled at Arundel Cove, Md., recently, it was found that the ship's old boilers would have to be removed and new ones substituted in their place. These had originally been set while the vessel was in the course of construction, and to lift them out bodily it would have been necessary to tear out a large section of the upper deck. As it was, the work was accomplished quickly by cutting the boilers into strips with oxyacetylene torches. Two men, each with a torch, cut through approximately 1000 ft. of steel plate, averaging 1 in. in thickness, in 30 working hours.

To save Pringle Hill and Courtdale, two mining villages on the west bank of the Susquehanna River, in Pennsylvania, from dropping into the mines, the Kingston Coal Company has begun operations that may result in the flushing of Pringle Mountain into worked-out veins. Stone crushers and steam shovels are being installed for this latest innovation in mining.

A number of plants in St. Louis, Mo., are producing commercial oxygen electrolytically. A 10 to 15 per cent. solution of caustic soda or caustic potash is employed. Through this a current of electricity is passed and the oxygen that collects at one electrode is trapped and led off to a compressor, while the hydrogen is permitted to escape.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 5.

1,123,311. AIR-MOTOR. JUSTUS R. KINNEY, Boston, Mass.

1,123,327. COMPRESSOR. CHARLES H. LEINERT, Chicago, Ill.

1,123,335. PNEUMATIC GRAIN-ELEVATOR. HENRY G. LYKKEN, Grand Forks, N. D.

1,123,372. DRILL-SHARPENER. THEODORE HIRAM PROSKE, Denver,, Colo.

1,123,426. PNEUMATIC CLEANING APPARATUS. ALBERT E. TOLIN, Anderson, Ind.

1,123,498. BOAT PROPULSION. REX DEAN, Findlay, Ohio.

1. An apparatus of the class described, comprising a vessel, a Venturi tube carried thereby, a pipe ring surrounding the restricted portion of said tube and provided with orifices leading to and communicating with the interior of said tube, said orifices curved and pointing in a rearward direction, and a pipe communicating with said pipe ring adapted to supply a gaseous medium thereto under pressure for the forcible projection of a liquid medium through said Venturi tube in a rearward direction, resulting in the forward propulsion of the boat.

1,123,527. ROTARY FLUID-PRESSURE MOTOR. HENRY J. HANZLIK, Trenton, N. J.

1,123,542. PROCESS OF AGITATING AND AERATING SUBSTANCES. WERNER JANENSCH, Charlottenburg, Germany.

1,123,588. APPARATUS FOR LIQUEFYING AND SEPARATING ATMOSPHERIC AIR. JAMES F. PLACE, Glen Ridge, N. J.

1,123,627. PNEUMATIC PLAYER. EUGENE T. TURNEY, New York, N. Y.

1,123,678. PNEUMATIC IMPACT-TOOL. WILLIAM BURLINGHAM, Newport News, Va.

1,123,684. GLASS-DRAWING APPARATUS. WILLIAM L. CLAUSE, Pittsburgh, Pa.

1,123,728. DRY SEPARATOR AND CONCENTRATOR. FRITZ HENRY GORDON, Portland, Oreg.

1. The combination with a separator comprising a frame, a shaker having a plurality of screen openings mounted to vibrate therein, a body portion adapted to receive air under pressure fixed beneath the screen openings, a receptacle in the body portion beneath each screen, and an air chamber at the rear of each receptacle leading from the body portion to the screened opening, of a forwardly inclined deflector in the shaker at the rear of each chamber and a forwardly closing valve at the outlet of each chamber.

1,124,082. AUTOMATIC BRAKE-SETTING MECHANISM FOR PNEUMATIC BRAKES. ROBERT J. WELDON, Fort Worth, Tex.

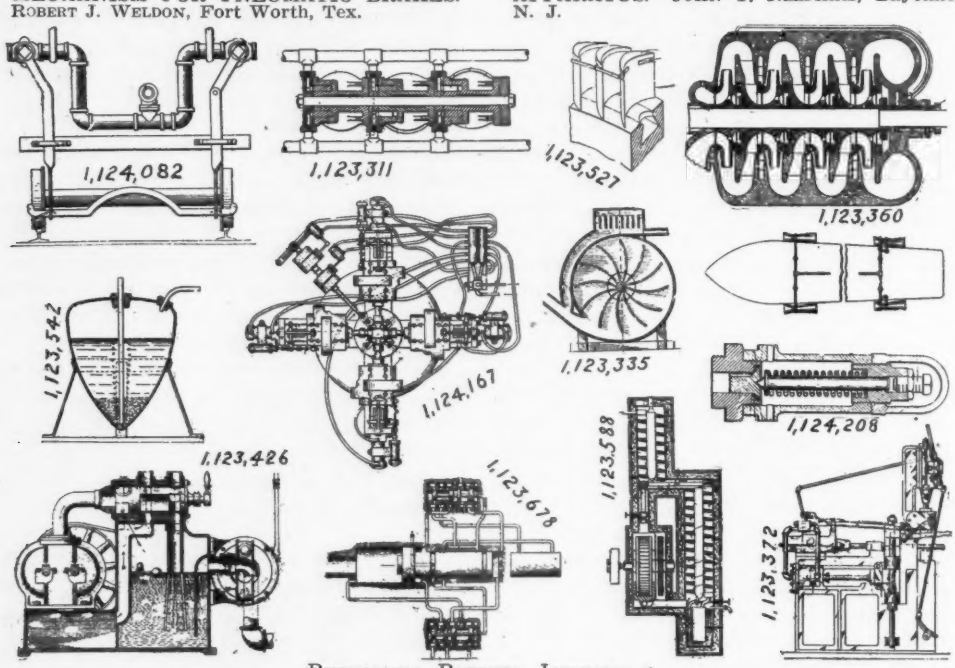
1,124,407. APPARATUS FOR TREATING ROADWAYS. SAM EVERETT FINLEY, Atlanta, Ga.

1. Apparatus for treating roadways with oil or the like, comprising a tank, multiple spray nozzles delivering rotary conical sprays to the road surface, a pump for delivering the material under pressure from the tank to said nozzles, and means to direct a blast of air on the roadway in advance of said rotary conical sprays.

1,124,409. ROTARY FLUID-PRESSURE MOTOR. FRANCIS M. FLOYD, Elkville, Ill.

1,124,460. AIR-MOTOR. GYULA KOESIS, St. Clairsville, Ohio, and JOHN LUKO, Latrobe, Pa.

1,124,505. PNEUMATIC - DESPATCH - TUBE APPARATUS. JOHN T. NEEDHAM, Bayonne, N. J.



PNEUMATIC PATENTS JANUARY 5.

1,124,167. PNEUMATICALLY - CONTROLLED MULTIPLE - SPINDLE TAPPING AND DRILLING APPARATUS. RAE W. PHILLIPS, Los Angeles, Cal.

1,124,200-1-2. AIR-BRAKE APPARATUS. HENRY F. BICKEL, Plainfield, N. J.

1,124,203. SAFETY-VALVE FOR AIR-BRAKE APPARATUS. JOHN W. BINGLEY, Watertown, N. Y.

JANUARY 12.

1,124,255. CONTROL FOR PNEUMATIC-DESPATCH APPARATUS. ROBERT BALL, Philadelphia, Pa.

1,124,285. DEVICE FOR WITHDRAWING BLOOD FROM THE BODY. PHILIP V. BROWN New York, N. Y.

1,124,304. PROCESS OF PRODUCING OXYGEN. PAUL DANCKWARDT, near Dardanelle, Ark.

1. The process of producing oxygen, which consists in heating a mixture containing alkali metal manganate or substances that will form this by heat. and one or more other substances forming a diluent, until the mass is fluid, introducing under pressure into this mass air and steam in such a way that the gases cannot mingle with each other, the pressure of the gases being materially greater than that due to the resistance of the molten mass, and collecting the gases separately.

1,124,539. PNEUMATIC STACKER. JOSEPH K. SHARPE, Jr., Indianapolis, Ind.

1,124,573. COMBINED VACUUM-CLEANER AND BLOWER. ERNEST L. B. ZIMMER, Oakland, Cal.

1,124,575. AIR CONTROL AND SIGHT ATTACHMENT FOR VACUUM - CLEANER TOOLS. ERNEST L. B. ZIMMER, Oakland, Cal.

1,124,600-1. METHOD OF RAISING AND PURIFYING WATER. WILLIAM S. FRANKLIN, South Bethlehem, Pa.

The method of purifying water consisting in causing ozonized air to pass through and lift a body of water, the ozonized air being under a constantly decreasing pressure throughout the entire time of contact.

1,124,684. PNEUMATIC CLEANER. GEORGE W. ALLEN, Boston, Mass.

1,124,830. SAND - RECLAIMER. HARRY L. ALLEN, Alliance, Ohio.

1. In a sand reclaimer, the combination of a pair of casings one within the other in spaced relation, perforated deflectors within said inner casing, said casing being provided with a plurality of openings at points beneath each of said deflectors, said openings providing communica-

tion with the spaces between said casings, means for partially exhausting the air within said casings and thereby removing dust from the sand, and means for admitting atmospheric air to said inner casing, substantially as described.

1,124,871. FLUID - PRESSURE - CONTROLLING MECHANISM FOR GLASS-DRAWING MACHINES. CHARLES DAY, Arnold, Pa.

1,124,872. AIR-VALVE FOR GLASS-DRAWING MACHINES. CHARLES DAY, Arnold, Pa.

1,124,886. PNEUMATICALLY - OPERATED TEAT-CUP. ALEXANDER GILLIES, Heidelberg, and HAROLD BARTRAM, Melbourne, Victoria, Australia.

1,124,979. VAPORIZING APPARATUS. CHARLES ALFRED WALDECK, Baltimore, Md.

1. In a vaporizing apparatus, a rotary cylinder, a stationary sleeve, means for admitting compressed air and chemicals to the said sleeve, a hollow journal on one end of the cylinder and extended into the sleeve, means for providing a water-tight joint between the sleeve and the hollow journal, and means for controlling the feed of chemicals to the cylinder.

1,124,997. VACUUM OR SUCTION SWEEPER. HOMER L. BOYLE, Lansing, Mich.

JANUARY 19.

1,125,118. COMPOUND BLOWER. CHARLES VOLNEY KERR, Wellsville, N. Y.

1,125,135. LUBRICATING DEVICE. BRACE LELAND, Winona, Minn.

1. In a device of the character described, in combination, a casing adapted to contain lubricating fluid, a source of compressed air, an outlet pipe leading from said casing, and a filling inlet pipe surrounding the outlet pipe and connected with the compressed air supply.

1,125,151. AIR-RETAINING VALVE FOR AIR-BRAKE APPARATUS. SPENCER G. NEAL, Los Angeles, Cal.

1,125,214. BRAKE - PIPE VENT - VALVE. WALTER V. TURNER and PATRICK H. DONOVAN, Edgewood, Pa.

1,125,215. EMPTY AND LOAD BRAKE APPARATUS. WALTER V. TURNER, Edgewood, Pa.

1,125,348. APPARATUS FOR PULSATING OR VARYING AIR OR FLUID PRESSURE. WILLIAM HENRY LAWRENCE, Melbourne, Victoria, Australia.

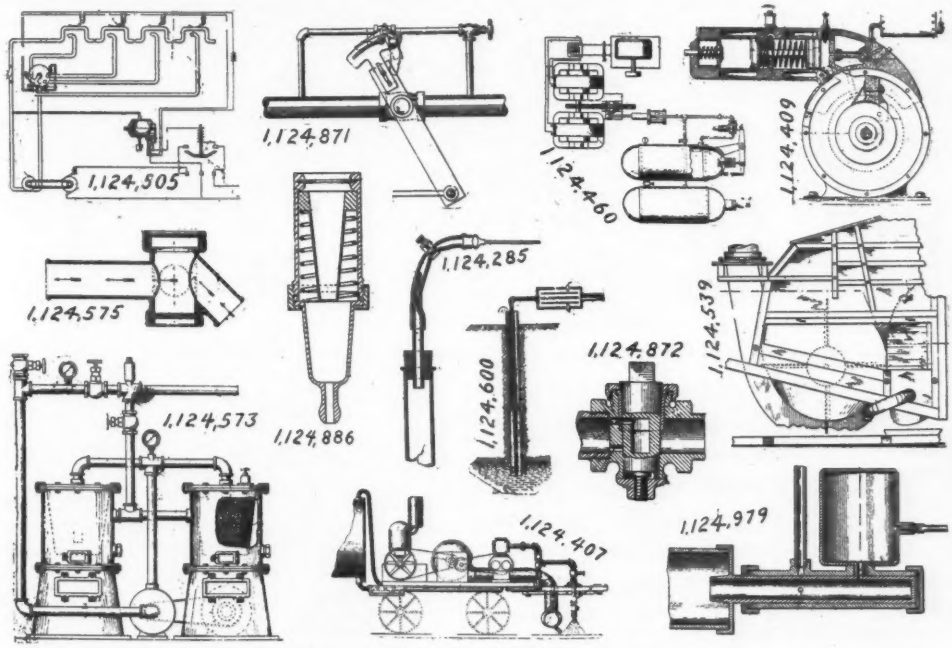
1,125,413. PNEUMATIC APPARATUS FOR TRANSFERRING MATERIAL. CHESTER J. VAN DOREN, Chanute, Kans.

1,125,480. MINE-DRILL SUPPORT. HOWARD P. CORSA, Bingham Canyon, Utah.

1,125,559. BLOWPIPE. AAGE KOFOD, Zurich, Switzerland.

1,125,593. FLUID POWER-TRANSMITTER. THOMAS D. W. PINCKNEY, New York, N. Y.

1,125,684-5. AIR-CIRCULATING DEVICE. LOUIS GREENBERG and GUSTAF OLSON, Chicago, Ill.



PNEUMATIC PATENTS JANUARY 12.

1,125,722. FLUID - PRESSURE ENGINE. JAMES DENNIS ROOTS, London, England.

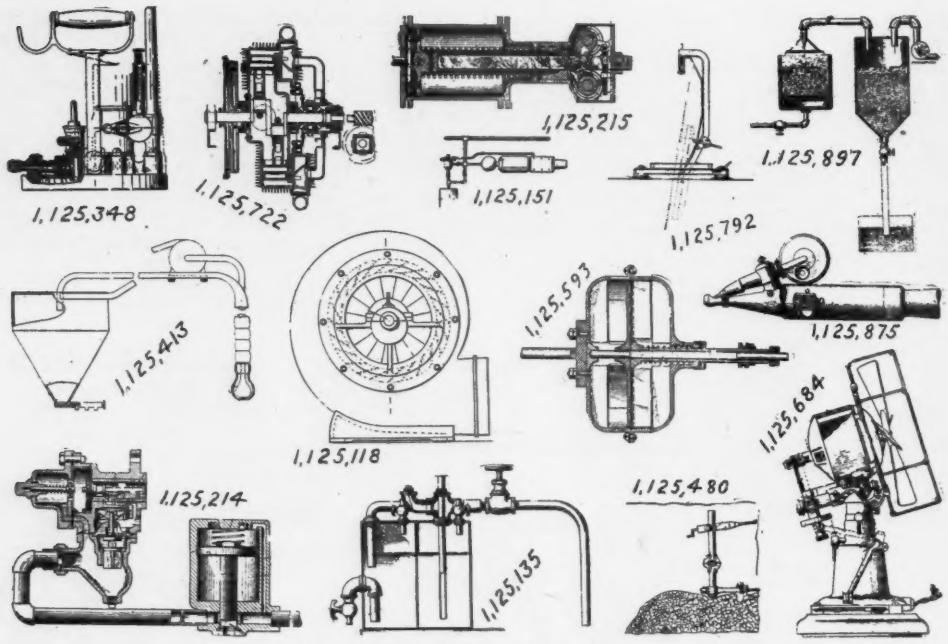
1,125,752. VACUUM LIFTING-MACHINE. CARLTON L. SMITH, Saginaw, Mich.

1,125,875. AIR-BRUSH. JENS A. PAASCHE, Chicago, Ill.

1,125,897. PROCESS OF CONCENTRATING ORES. JOHN M. CALLOW, Salt Lake City, Utah.

1. The process herein described of breaking down and discharging the froth, foam or sud, accumulating on the surface of an aerated and agitated mineral-bearing pulp containing a frothable agent having a selective affinity for metalliferous particles, said process consisting, essentially, in producing in a vessel open to the atmosphere a difference in pressures between the inside and outside of the air bubbles forming the froth, foam or sud, and conducting the fluid contents of the broken down bubbles and mineral particles thereof to a receiver.

1,125,900. OZONATOR. ARTHUR R. DARLING, Indianapolis, Ind.



PNEUMATIC PATENTS JANUARY 19.

JANUARY 26.

1,125,930. BARREL-CLEANING APPARATUS. HEINRICH WILHELM ARNEMANN, Hamburg, Germany.

1,126,004. COOLER FOR ROTARY COMPRESSORS. WILLIBALD GRUN, Frankfort-on-the-Main, Germany.

1,126,011. AIR-HEATER. RICHARD L. HUBBARD, Astoria, N. Y.

1,126,041. AIR-PUMP STARTER. CARL E. L. LIPMAN, Beloit, Wis.

1,126,096. PNEUMATIC HAMMER. WILLIAM F. SCHMIDT, St. Louis, Mo.

1,126,130. BARREL-PITCHING MACHINE. HARRY TORCHIANI, Chicago, Ill.

1,126,233. VACUUM-GAGE. IRVING LANGMUIR, Schenectady, N. Y.

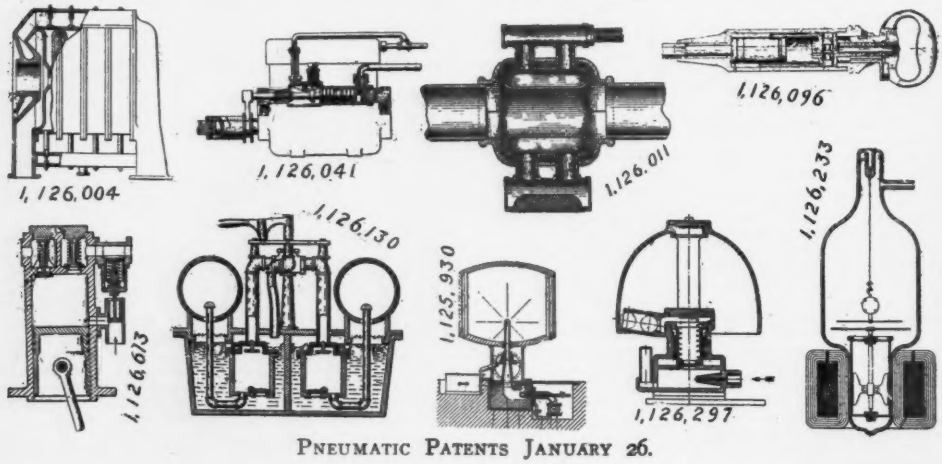
1,126,297. FLUID - PRESSURE - OPERATED ALARM DEVICE. HARRY E. W. SAUVEUR, Boxhagen-Berlin, Germany.

1,126,300. CENTRIFUGAL PUMP, BLOWER, COMPRESSOR, AND THE LIKE. EMIL SCHNEIDER, Hamburg, Germany.

1,126,371. PROCESS OF PURIFYING HYDROGEN GAS. CARL BOSCH and WILHELM WILD, Ludwigshafen-on-the-Rhine, Germany.

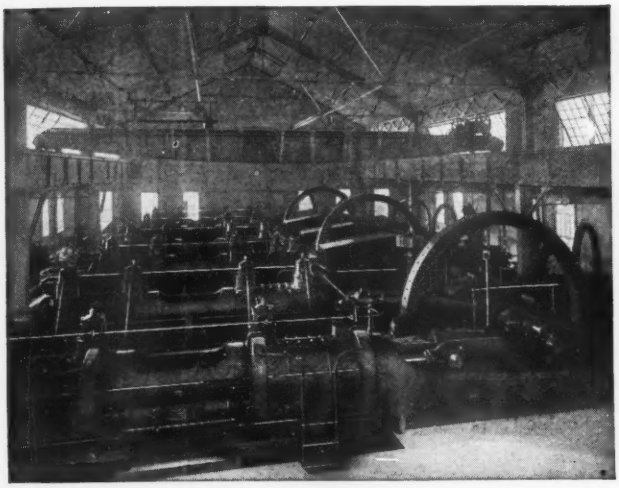
1. The process of producing pure hydrogen consisting in heating hydrogen containing small quantities of carbon monoxid under a pressure exceeding five atmospheres with a solution of caustic alkali.

1,126,613. AIR-PUMP. GEORGE BRANDSTETTER, Hohenstadt, and RICHARD FREUND, Vienna, Austria-Hungary.



PNEUMATIC PATENTS JANUARY 26.

COOPER GAS ENGINES



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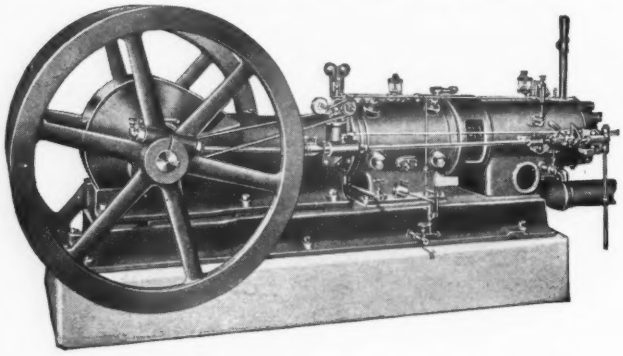

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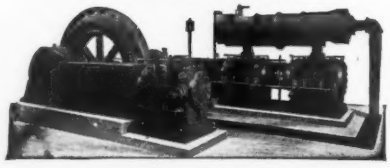

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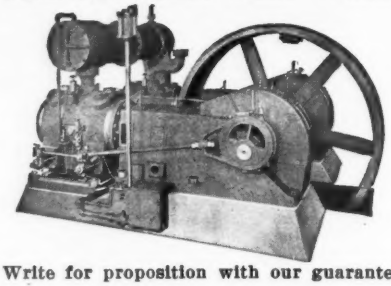

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